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John F. Kennedy Space Center

ENVIRONMENTAL RESOURCES DOCUMENT

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The purpose of the Environmental Resources Document for KSC is to fulfill the requirements of the National Aeronautics and Space Administration (NASA) Management Instruction (NMI) 8800.7D, Procedures for Implementing the Provisions of the National Environmental Policy Act (NEPA), as specifically stipulated in 14 Code of Federal Regulations (CFR), Section 1216.319. That directive states in part: Each Field Installation Director shall ensure that there exists an Environmental Resources Document, which describes the current environment at that field installation, including current information on the effects of NASA operations on the local environment.

Record of Revisions/Changes

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	Basic Issue	November 1986
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B	General Revision (Updated)	October 1994
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<u>List of Effective Pages</u>

Insert Latest changes; destroy superseded pages

NOTE:

The portion of the text affected by the change is indicated by a vertical line in the outer margin of the page.

THIS IS A GENERAL REVISION OF THE ENTIRE DOCUMENT CONSEQUENTLY ALL PAGES OF THE ISSUE ARE EFFECTIVE.

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Abbreviations/Acronyms

^oC	Degrees Celsius
^oF	Degree Fahrenheit
45SW	45th Space Wing/Patrick Air Force Base
ACHP	Advisory Council on Historic Preservation
ACI	Archaeological Consultants, Inc.
ACOE	U.S. Army Corps of Engineers
AET	Actual Evapotranspiration
AF	Air Force
AFV	Alternative Fueled Vehicle
AG	Agriculture
Ag	Silver
AIRFA	American Indian Religious Freedom Act
Al	Aluminum
Al_2O_3	Aluminum oxide
a.m.	Ante Meridian
AO	Airfield Operations
AOC	Areas of Concern
ARPA	Archaeological Resources Protection Act
AS	Artifact Scatters
As	Arsenic
AST	Aboveground Storage Tank
ATE	Actual Evapotranspiration
avg.	Average
Ba	Barium
BCC	Brevard Community College
BCMCD	Brevard County Mosquito Control District
Be	Beryllium
Bm	Burial Mounds
BMCD	Brevard Mosquito Control District
BOC	Base Operations Contract
BOD	Biochemical Oxygen Demand
BTU	British Thermal Units
Ca	Calcium

Abbreviations/Acronyms (continued)

CA	Corrective Action
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CCAFS	Cape Canaveral Air Force Station
CCF	Components Cleaning Facility
CCF	Corrosion Control Facility
CCSMP	Cape Canaveral Spaceport Master Plan
Cd	Cadmium
CDP	Census Designated Place
CEM	Cemeteries
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFC	Combined Federal Campaign
CFR	Code of Federal Regulations
CG	Cloud-to-Ground
CIF	Central Instrumentation Facility
CITESCl, Cl_2	Convention on International Trade in Endangered Species of Wild Fauna and Flora
Cl, Cl_2Cl, Cl_2	Chlorine
Cm	Centimeter
cm^2	Square centimeter
cm^3	Cubic centimeter
CNS	Canaveral National Seashore
Co	Cobalt
CO	Conservation
CO	Carbon monoxide
CO_2	Carbon dioxide
COE	U.S. Army Corps of Engineers
Col.	Colonel
CPG	Comprehensive Procurement Guideline
CPUE	Catch per unit effort
Cr	Chromium
CRCA	Component Refurbishment & Chemical Analysis

Abbreviations/Acronyms (continued)

CRF	Canister Rotation Facility
CRMP	Cultural Resources Management Plan
Cu	Copper
cu ft	Cubic Foot
cu yd	Cubic Yard
CUP	Consumptive Use Permit
CWA	Clean Water Act
CY	Calendar year
CZMA	Coastal Zone Management Act
dB	Decibel
dBA	Decibel
DDT	Dichlorodiphenyltrichloroethane
Dep	Department of Environmental Protection
DESC	Defense Energy Support Center
DHR	Division of Historical Resources
DNA	Deoxyribonucleic Acid
DO	Dissolved Oxygen
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DOT	Department of Transportation
Dth	Dekatherms
E	East
E	Endangered
E&O	Engineering and Operations
EA	Environmental Assessment
EAOR	Electronic Annual Operating Report
ECS	Engineering Control System
EDL	Engineering Development Laboratory
EELV	Evolved Expendable Launch Vehicle
EHS	Extremely Hazardous Substances
EIS	Environmental Impact Statement
ELV	Expendable Launch Vehicles

Abbreviations/Acronyms (continued)

ENE	East Northeast
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPB	Environmental Program Branch
EPCRA	Emergency Planning and Community Right to Know Act
EPNdBA	Effective Perceived Noise Level
ERC	Environmental Regulatory Document
ERD	Environmental Resources Document
ERP	Environmental Resource Permit
ET	External Tank
EU	Emission Units
EWG	Energy Working Group
FAA	Federal Aviation Administration
FAAQS	Florida Ambient Air Quality Standards
FAC	Florida Administrative Code
FAR	Federal Acquisition Regulations
FAWPCA	Florida Air and Water Pollution Control Act
FCREPA	Florida Committee on Rare and Endangered Plants and Animals
FDA	Food and Drug Administration
FDAC	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Regulation
FDNR	Florida Department of Natural Resources
FDOT	Florida Department of Transportation
Fe	Iron
FEC	Florida East Coast
FFDCA	Federal Food, Drug, and Cosmetics Act
FEMA	Federal Emergency Management Agency
FFWCC	Florida Fish and Wildlife Conservation Commission
FGFWFC	Florida Game and Fresh Water Fish Commission
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FIRM	Flood Insurance Rate Maps
FLUCCS	Florida Land Use Cover and Forms Classification System
FM	Fathoms

Abbreviations/Acronyms (continued)

FNAI	Florida Natural Areas Inventory
FP	Fibropapillomatosis
FPL	Florida Power and Light Company
F.S.	Florida Statutes
FSA	Fuel Storage Area
FSEC	Florida Solar Energy Center
FSS	Fixed Service Structure
ft	Feet
ft/day	Feet per day
FWS	Fish and Wildlife Services
g-cal	Gram-calorie
gal	Gallon
GC/MS	Gas Chromatography/Mass Spectroscopy
GH_2	Gaseous hydrogen
GIS	Geographic Information System
GN_2	Gaseous nitrogen
GIS	Geographic Information System
GO	Government Office
GO_2	Gaseous oxygen
GPD	Gallons per day
GPD/ft	Gallons per day per foot
gpm	Gallons per million
GSA	General Services Administration
GSFC	Goddard Space Flight Center
Ha	Hectare
HAP	Hazardous Air Pollutants
HB	High Bay
HCFC	Hydrochlorofluorocarbons
H_2	Hydrogen
H_2O	Water
H_2S	Hydrogen sulfide
HC	Hydrocarbons
HCl	Hydrogen Chloride

Abbreviations/Acronyms (continued)

Hg	Mercury
HIS	Historical
HMF	Hypergol Maintenance Facility
HMTA	Hazardous Materials Transportation Act
HQ	Headquarters
Hr	Hour
HR	Historic refuse deposits
HSWA	Hazardous and Solid Waste Amendments
HVAC	Heating, Ventilation and Air Conditioning
In	Inches
IPA	Isopropyl Alcohol
IRL	Indian River Lagoon
IRLS	Indian River Lagoon System
ISRP	International Space Research Park
IWW	Industrial Wastewater
J	Joule
JBOSC	Joint Base Operating Support Contract
JP	Jet Propellant
JTU	Jackson Turbidity Units
K	Potassium
KARS	Kennedy Athletic, Recreational and Social Organization
KDP	Kennedy Documented Procedure
kg	Kilogram
KHB	KSC Handbook
kl	Kiloliter
KMI	KSC Management Instruction
km	Kilometer
km^2	Square kilometer
KMLP	Kennedy Multicultural Leadership Program
KSC	Kennedy Space Center
Kts	Knots
KV	Kilovolt
L	Liter

Abbreviations/Acronyms (continued)

LA	Launch
Lb	Pound
lbs/hr	Pounds per hour
LC-17	Launch Complex 17
LC-36	Launch Complex 36
LC-39	Launch Complex 39
LCC	Launch Complex Center
LEPC	Local Emergency Planning Committee
LETF	Launch Equipment Test Facility
LH_2	Liquid hydrogen
LMP	Light Management Plan
LN_2	Liquid nitrogen
LOC	Launch Operations Center
LOD	Launch Operations Directorate
LS	Launch Support
LS	Lithic Scatters
LUC	Land Use Controls
LUCIP	Land Use Control Implementation Plan
LUT	Launch Umbilical Tower
M	Meter
M^3	Cubic meter
M&O	maintenance and operations
MACT	Maximum Achievable Control Technology
max	Maximum
Mbtu	Million British thermal units
MFL	Missile Firing Laboratory
Mg	Magnesium
MGD	Million gallons per day
Mg/L	Milligrams per liter
Mg/m^3	Milligrams per cubic meter
Mi	Mile
mi^2	Square mile
MID	Middens

Abbreviations/Acronyms (continued)

MILA	Merritt Island Launch Area
Min	Minimum, Minute
MINWR	Merritt Island National Wildlife Refuge
MLP	Mobile Launcher Platform
MM	Million or 106
MM BTU/hr	Million British Thermal Units per hour
MM BTU/hr	Monomethylhydrazine
MMH	Monomethyl Hydrazine
Mn	Manganese
MOA	Memorandum of Agreement
MOSB	Multi-Operation Support Building
MOU	Memorandum of Understanding
MS4s	Municipal Separate Storm Sewer Systems
MSBLS	Microwave Scanning Beam Landing System
MSDS	Material Safety Data Sheets
MSL	Mean sea level
MSOB	Multi-Operation Support Building
MSS	Mobile Service Structure
MSFC	Marshall Space Flight Center
m.t.	Metric Ton
MWh	MegaWatthours
N	Newton
N	North
N_2	Nitrogen
N/m^2	Newtons per square meter
Na	Sodium
NaOH	Sodium hydroxide
NAAQS	National Ambient Air Quality Standards
NADP	National Air Deposition Program
NAGPRA	Native American Graves Protection and Repatriation Act
NASA	National Aeronautics and Space Administration
NDEL	Non-Destructive Evaluation Laboratory
NDP	NASA Policy Directive

Abbreviations/Acronyms (continued)

NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NETS	NASA Environmental Tracking System
NGVD	National Geodetic Vertical Datum
NHB	NASA Handbook
NHPA	National Historic Preservation Act
Ni	Nickel
Nitr	Nitrate
NM	Nautical mile
NMFS	National Marine Fisheries Services
NMI	NASA Management Instruction
No.	Number
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides
NOTU	Naval Ordnance Test Unit
NPDES	National Pollution Discharge Elimination System
NPG	NASA Procedures and Guidelines
NPS	National Park Service
NRHP	National Register of Historic Places
NSPS	News Source Performance Standards
NSR	New Source Review
NTDL	Non-Destructive Evaluation Lab
NUI	National Utility Investors
NURTURE	NASA's Unique Resident Tutoring for Up-and-Coming Replacement Engineers
NW	Northwest
O_3	Ozone
O&C	Operations & Checkout
O&M	Operations and Maintenance
ODC	Ozone-Depleting Chemical
ODS	Ozone-Depleting Substances
OFW	Outstanding Florida Waters
OMB	Office of Management and Budget
OMRF	Orbiter Modification and Refurbishment Facility

Abbreviations/Acronyms (continued)

OPF	Orbiter Processing Facility
OS	Open Space
OSB	Operations Support Building
OSHA	Occupational Safety and Health Administration
OZ	Ounce
P^2	Pollution Prevention
pH	PH
PAFB	Patrick Air Force Base
PAH	Polyaromatic Hydrocarbons
PAMS	Permanent Air Monitoring System
Pb	Lead
PCB	Polychlorinated Biphenyls
PCR	Payload Changeout Room
PET	Potential Evapotranspiration
PGOC	Payload Ground Operations Contract
PHSF	Payload Hazardous Servicing Facility
Phos	Phosphate
PIR	Pollution Incident Report
PL	Public Law
p.m.	Post Meridian
PM	Particulate Matter
PO	Public Outreach
PO_4	Phosphate
POL	Paint and Oil Locker
POP	Permanent Operating Permit
ppb	Parts per billion
ppm	Parts per million
ppt	Parts per thousand
PRF	Parachute Refurbishment Facility
PRL	Potential Release Location
PSD	Prevention of Significant Deterioration
Psf	Pound(s) per square foot
PSM	Process Safety Management

Abbreviations/Acronyms (continued)

QD	Quality Distance
Qt	Quart
R&D	Research and Development
RACM	Regulated Asbestos-Containing Material
RADL	Robotics Applications Development Laboratory
RCRA	Resource Conservation & Recovery Act
RE	Recreation
REEDM	Rocket Exhaust Effluent Diffusion Model
REV	Revision
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RICE	Reciprocating Internal Combustion Engines
RHA	Rivers and Harbors Act of 1899
RMP	Risk Management Program
ROCC	Range Operations Control Center
RP	Rocket Propellant
RPSF	Rotation, Processing and Surge Facility
RRMF	Reutilization, Recycling, and Marketing Facility
RSS	Rotating Service Structure
SA	Single Artifacts
SAEF	Spacecraft Assembly and Encapsulation Facility
Sal	Salinity
SAV	Submerged Aquatic Vegetation
Sb	Freddium
SDWA	Safe Drinking Water Act
Se	Selena
SE	Seaport
SE	Southeast
SEARCH	Science Engineering and Research Career Help
SERC	State Emergency Response Commission
SERPL	Space Experiments Research and Processing Laboratory
SFOC	Shuttle Facility Operations Contract
SGS	Space Gateway Support

Abbreviations/Acronyms (continued)

SHARP	Summer High School Research Apprentice Program
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SJRWMD	St. Johns River Water Management District
SLF	Shuttle Landing Facility
SM	Spaceport Management
SM	Shell Middens
SNAP	Significant New Alternatives Policy
SO_2	Sulfur dioxide
SO_X	Sulfur oxides
SPC	Shuttle Processing Contract
SPCC	Spill Prevention, Control and Countermeasure Plan
Sq.M	Square Meter
SR	State Road
SRB	Solid Rocket Boosters
SRB-ARF	Solid Rocket Boosters Assembly & Refurbishment Facility
SSC	Species of Special Concern
SSPF	Space Station Processing Facility
St. Dev.	Standard Deviation
STDL	Spaceflight Tracking and Data Network
STP	Sewage (Wastewater) Treatment Plant
STS	Space Transportation System
SWIM	Surface Water Improvement and Management
SWMU	Solid Waste Management Unit
T	Threatened
T(S/A)	Threatened because of similarity of appearance to another protected species
TDS	Total Dissolved Solids
Temp	Temperature
Ti	Tinactin
TKN	Total Kjeldahl Nitrogen
TOP	Temporary Operating Permit
TRI	Toxic Release Inventory
TRMM	Tropical Rainfall Mesoscale Monitoring

Abbreviations/Acronyms (continued)

TPS	Thermal Protection System
TPSF	Thermal Protection System Facility
TSCA	Toxic Substances Control Act
TSDF	Transportation, Storage and Disposal Facility
µ	Micro-, micron
µg/L	Micrograms per liter
µg/m3	Micrograms per cubic meters
UNK	Unknown
URTD	Upper Respiratory Tract Disease
U.S.	United States
USACOE	U.S. Army Corps of Engineers
USAF	United States Air Force
USBI	United Space Booster Inc.
U.S.C.	U.S. Code
USDA	U.S. Department of Agriculture
USDOI	U.S. Department of Interior
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
USPHS	U.S. Public Health Service
UST	Underground Storage Tank
UV	Ultra Violent
VAB	Vehicle Assembly Building
VAFB	Vandenberg Air Force Base
VIC	Visitor Information Center
Vn	Vanadium
VOC	Volatile Organic Compound
VOL	Volatile Organic Liquid
VPF	Vertical Processing Facility
WMA	Waste Management Authority
Yr	Year
YSI	calibrated field instrument
ZAP	Zones of Archaeological Potential
Zn	Zinc

Conversion Factors

Area

1 acre = 0.4047 ha

1 ft3 = 0.0283 m3

1 ft2 = 0.0930 m2

1 hectare = 2.4710 acres

1 in2 = 6.4516 cm2

1 mi2 = 2.5900 km2

1 square centimeter = 0.1550 square inch

1 square kilometer = 0.3861 square mile

1 square meter = 10.7527 square feet

Energy

joule = 0.0009 British thermal unit

joule = 0.2392 gram-calorie

1 BTU = 1060.4 j

1 g-cal = 4.181 j

Linear

1 centimeter = 0.3937 inch

1 centimeter = 0.0328 foot

1 ft = 30.48 cm

1 ft = 0.3048 m

1 in = 2.54 cm

1 kilometer = 0.6214 mile

1 kilometer = 0.5396 nautical mile

1 meter = 3.2808 feet

1 meter = 0.0006 mile

1 mi = 1609.3440 m

1 mi = 1.6093 km

1 NM = 1.8520 km

Pressure

Newton/square meter = 0.0208 pound/square foot

1 psf = 48 N/m2

Thrust

pound (of thrust) = 4.4 Newtons

1 N (of thrust) = 0.2273 lbs

Volume

1 cubic centimeter = 0.0610 cubic inch

1 cubic meter = 35.3357 cubic feet

1 gal = 3.7844 l

1 gal = 0.0038 kl

1 in3 = 16.3934 cm3

1 in3 = 16.3934 cm3

kiloliter = 264.2 gallons

1 liter = 1.0567 quarts

1 liter = 0.2642 gallon

1 qt = 0.9463 l

Weight

gram = 0.0353 ounce

kilogram = 2.2046 pounds

metric ton = 1.1023 tons

1 lb = 0.4536 kg

1 oz = 28.3286 g

1 ton = 0.9072 m.t.

SECTION I

ERD INTRODUCTION

1.1 PURPOSE OF THE ENVIRONMENTAL RESOURCES DOCUMENT

The National Environmental Policy Act (NEPA) of 1969, Public Law 91-190, requires that all Federal agencies consider the environmental effects of proposed actions. The Act also specifies that Federal agencies shall adopt both administrative regulations and policies and procedures to ensure decisions are made in accordance with the provisions of NEPA. The regulations that Federal agencies must follow when implementing NEPA are prepared by the Council on Environmental Quality (CEQ) and published at 40 CFR Parts 1500-1508.

NASA has developed Agency-specific guidance in accordance with the CEQ regulations. The policies and procedures are published in 14 CFR Part 1216. Although not required by NEPA or CEQ regulations, NASA mandates the preparation of a resource document as follows:

> Each Field Installation Director shall ensure that there exists an Environmental Resources Document (ERD), which describes the current environment at that field installation, including current information on the effects of NASA operations on the local environment. This document shall include information on the same environmental effects as included in an Environmental Impact Statement (reference 14 CFR 1216.307). This document shall be coordinated with the Associate Administrator for Management and shall be published in an appropriate NASA report category for use as a reference document in preparing other environmental documents [14 CFR 1216.319].

The ERD provides the current status and a description of the different environmental areas and operations at the Center. The document serves as a baseline against which the effects of proposed actions can be judged to determine a possible environmental impact. The KSC ERD is programmed to be updated continually as required by changing conditions (by page change or other simple technique) and to be reviewed thoroughly at 5-year intervals (and revised, if necessary) to ensure adequacy. The present document represents the fourth revision of the original ERD completed in 1986.

1.2 ENVIRONMENTAL RESOURCES DOCUMENT ORGANIZATION

This document is organized into 15 sections according to the various environmental aspects or media related to the Center. Appendices, exhibits, figures and tables are included to provide additional information, as needed. Most chapters have the following structure:

Regulatory Overview – Review of applicable regulations, Executive Orders, and other guidance as they relate to that media at KSC including both Federal and State information.

Operations – Review of the operational and physical aspects of that media at KSC.

1.3 KENNEDY SPACE CENTER'S ENVIRONMENTAL PROGRAM

KSC's environmental policies are contained in the KSC Environmental Handbooks, KHB 8800.6 and KHB 8800.7. These manuals describe policies, procedures and responsibilities for each environmental program area, such as air, water, and NEPA.

The NASA Environmental Program Branch (EPB) manages the environmental program and environmental compliance at KSC. EPB is responsible for obtaining and maintaining the Center's environmental permits. The Center frequently undergoes both internal and external environmental audits and inspections. All onsite regulatory reviews are coordinated through EPB with minimum impact to Center operations.

SECTION II

DESCRIPTION OF INSTALLATION

2.1 FACILITY BACKGROUND

Early in 1962, NASA began acquiring property for a space center as a base for launch operations in support of the Manned Lunar Landing Program. Approximately 34,000 hectares (ha) (84,000 acres (ac)) were purchased on Merritt Island in the northern part of Brevard County extending into the southernmost tip of Volusia County. An additional 22,660 ha (56,000 ac) of state-owned submerged land (Mosquito Lagoon, etc.) were negotiated with the State of Florida for exclusive rights dedicated to the United States. This total area of nearly 56,660 ha (140,000 ac), together with the adjoining water bodies, was considered extensive enough to provide adequate safety for the surrounding communities from the planned vehicle launches.

2.2 LOCATION DESCRIPTION

Kennedy Space Center (KSC) is located on the east coast of Florida. The Center itself is situated approximately 242 km (150 mi) south of Jacksonville and 64 km (40 mi) due east of Orlando on the north end of Merritt Island adjacent to Cape Canaveral (see Figure 2-1).

KSC is relatively long and narrow, being approximately 56 km (35 mi) in length and varying from 8 to 16 km (5 to 10 mi) in width. Bordered on the west by the Indian River (actually a brackish-water lagoon) and on the east by the Atlantic Ocean and the Cape Canaveral Air Force Station (CCAFS). The northernmost end of the Banana River (another brackish-water lagoon) lies between Merritt Island and CCAFS and is included as part of KSC submerged lands. The southern boundary of KSC runs east west along the Merritt Island Barge Canal, which connects the Indian River with the Banana River and Port Canaveral at the southern tip of Cape Canaveral. The northern border lies in Volusia County near Oak Hill across Mosquito Lagoon. The Indian River, Banana River, and the Mosquito Lagoon collectively make up the Indian River Lagoon System (IRLS).

Only a very small part of the total acreage of KSC has been developed or designated for NASA operational and industrial use (see Figure 2-2). Merritt Island consists of prime habitat for unique and endangered wildlife; therefore, NASA entered into an agreement with the U.S. Fish and Wildlife Service (USFWS) to establish a wildlife preserve, known as the Merritt Island National Wildlife Refuge (MINWR), within the boundaries of KSC. Public Law 93-626 created the Canaveral National Seashore (CNS); thereby, an agreement with the Department of the Interior (USDI) was also formed due to the location of CNS within KSC boundaries (see Figure 2-2).

2.3 NASA's VISION AND MISSION

NASA's vision is: To improve life here; to extend life to there; and to find life beyond. NASA's mission is: To understand and protect our home planet; to explore the Universe and search for

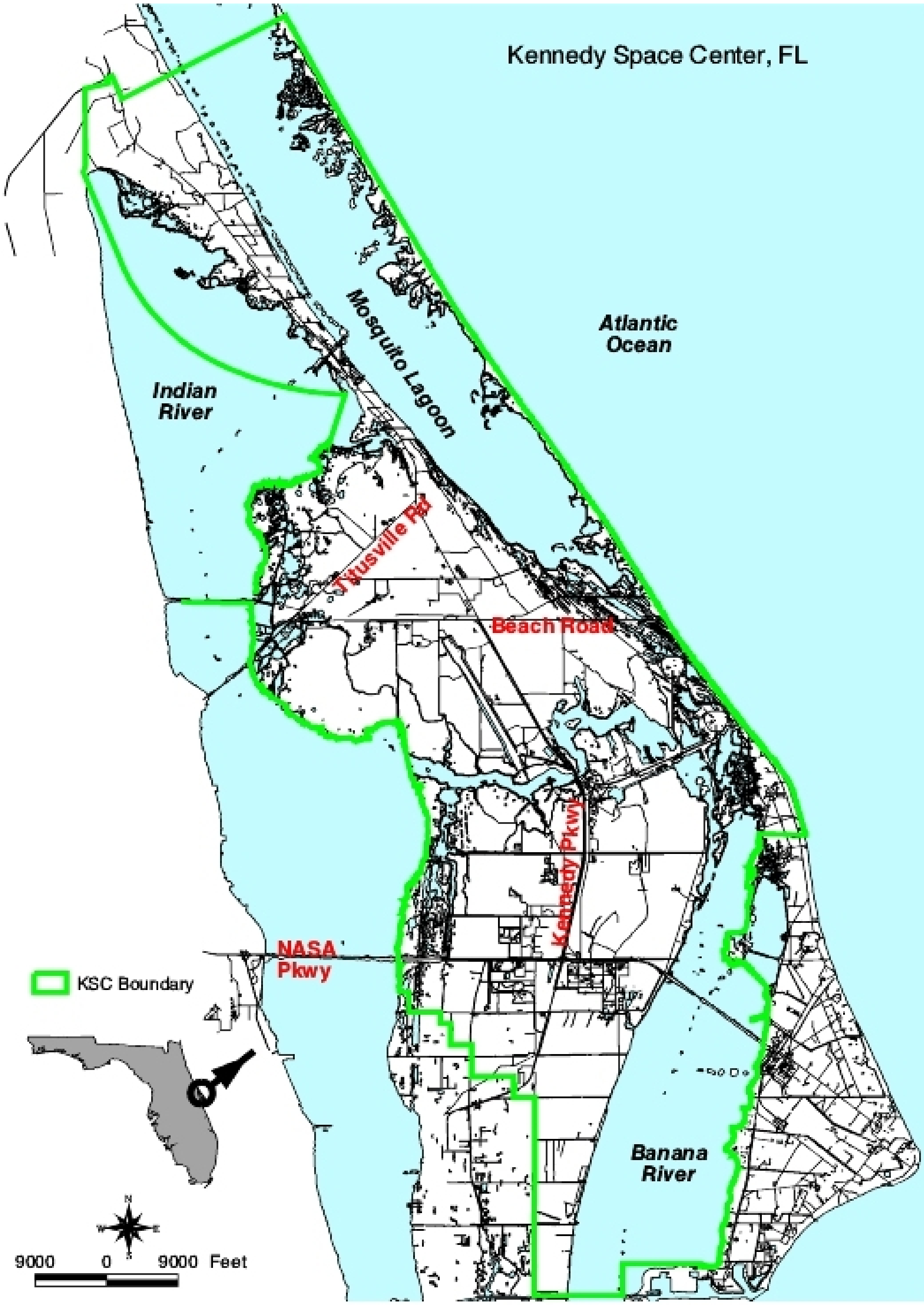

Figure 2-1. KSC Location.

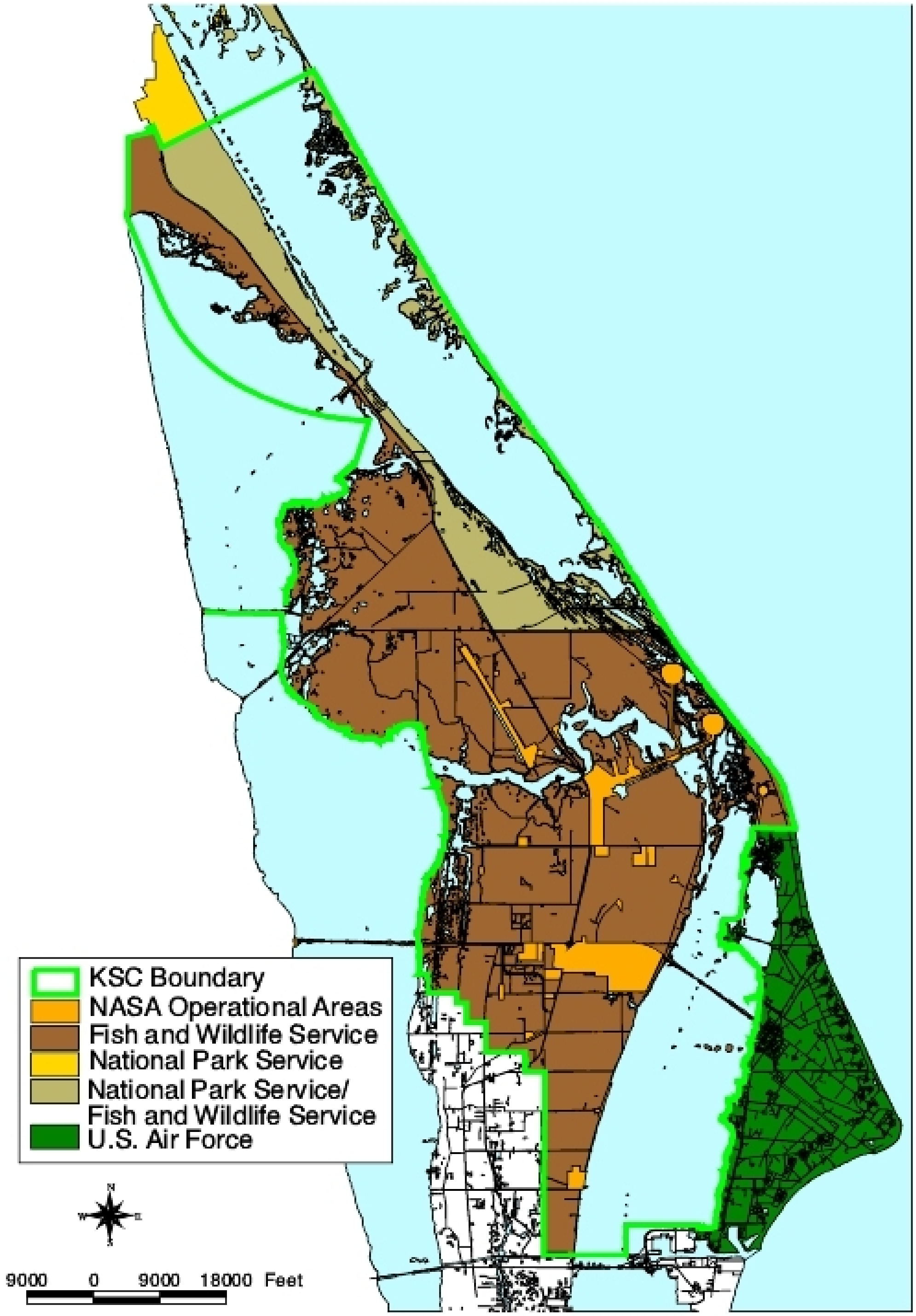

Figure 2-2. KSC Administrative Areas.

life; and to inspire the next generation of explorers…as only NASA can. NASA is organized along five basic mission driven areas: (1) Space Science, (2) Earth Science, (3) Biological and Physical Science, (4) Aeronautics, and (5) Education. In addition, NASA functions using four basic Enabling Capabilities: (1) Space Flight, (2) Crosscutting Technology, (3) Safety and Mission Assurance, and (4) Institutional Support.

2.4 KSC'S MISSION

Liftoff at the Kennedy Space Center! These words inspire people around the world as another space mission begins to explore our limitless universe. The two primary functions at KSC are the processing and launching of the Space Shuttle and the processing of payloads for launch aboard the various Expendable Launch Vehicles (ELVs) processed and launched from the CCAFS. KSC has four guiding principles: (1) Safety and Health First, (2) Build Reliance and Teamwork Everywhere, (3) Satisfy Our Customers' Needs Anytime, Anywhere, and (4) Environmental Leadership.

2.5 KSC AND CCAFS FACILITY PLANNING FOR THE CAPE CANAVERAL SPACEPORT

<u>The Process and Partnerships</u> - In 2000, NASA at KSC formed financial partnerships with the Air Force 45th Space Wing at CCAFS and Florida Space Authority, the State's economic development entity for the space industry, to perform joint planning for the land mass, which encompasses both KSC and CCAFS, known as Cape Canaveral Spaceport (CCS). Also included in the leadership team for the planning activity were representatives from the USFWS, the U.S. Navy Ordnance Test Unit, and CNS. The leadership team developed a long-range vision and land use plan for the future development of CCS to embrace the future launch market, emerging new technologies, and possible changes in National and global space policies.

<u>The Product</u> - Because the Cape Canaveral Spaceport Master Plan (CCSMP) is a dynamic document, for detailed information refer to the current revision available on the KSC internal web page at http://spaceport.ksc.nasa.gov/offices/nasaafmgmt/masterplan.cfm. The CCSMP contains a vision statement and planning criteria, information regarding current transportation infrastructure and analyses, the forecasts for future launch and tourism markets, and suggestions for implementation of the CCSMP. Most importantly, the CCSMP contains a future land use map with 13 categories of land use, as well as conceptual renderings for activity centers to support spaceport administration and launch and launch-related services.

<u>Ancillary Sources of Facility Information</u> - Additional information about land and facilities at KSC can be found within the CCAFS Basic Information Guide, Document Number KSCGP 14-2, prepared by SGS Master Planning.

2.6 FACILITIES INFORMATION

KSC facilities, equipment and personnel provide a variety of functions in support of their mission:

- Assemble, integrate, and validate Space Shuttle elements along with associated payloads including International Space Station (ISS) elements and upper stage boosters
- Conduct launch, recovery, and landing operations
- Design, develop, construct, operate, and maintain each launch and landing facility and the associated support facilities
- Maintain ground support equipment required to process launch vehicle systems and their associated payloads
- Serve as the NASA point-of-contact for Department of Defense (DOD) launch activities and provide logistics support to NASA activities at KSC, CCAFS, Patrick Air Force Base (PAFB), Vandenberg Air Force Base (VAFB), and various contingency and secondary landing sites around the world
- Manage Shuttle flight hardware logistics
- Research and develop new technologies to support space launch and ground processing activities
- Provide Government oversight and approval authority for commercial ELV operations.

2.6.1 SPACE SHUTTLE PROCESSING FACILITIES

Space Shuttle processing activities are primarily performed within Launch Complex 39 (LC-39). This area contains the Vehicle Assembly Building (VAB), Launch Control Center (LCC), Orbiter Processing Facilities (OPF), Launch Complexes 39A and 39B, and other operational facilities, as well as support facilities. In the KSC Industrial Area, the Hypergolic Maintenance Facility and associated support buildings provide capability for Space Shuttle component processing. In addition, some facilities on CCAFS support Space Shuttle processing and logistics requirements.

- VAB – K6-848
- LCC – K6-900
- OPF High Bays 1, 2, and 3, including the Space Shuttle Main Engine Facility (OPF HB's 1, 2, and 3) – K6-894, K6-696
- Thermal Protection System Facility (TPSF) - K6-794
- Crawler Maintenance Facility - K6-743
- LC-39A and LC-39B – J8-1798 (A) and J7-337 (B)
- Hypergol Maintenance Facilities (HMF) – M7-1061, M7-961, M7-1212, and HMF Support Building #2 (M7-1059)
- Shuttle Landing Facility (SLF)
- Operations Support Building (OSB) – K6-1096
- Component Refurb and Chemical Analysis (CRCA) (K6-1696)
- Logistics Facility – K7-1547
- Rotation, Processing and Surge Facility (RPSF)
- Hangar AF
- Hangar S Annex
- Hangar N

2.6.2 PAYLOAD AND INTERNATIONAL SPACE STATION ELEMENT PROCESSING FACILITIES

ISS elements are processed primarily in the Space Station Processing Facility on the east end of the KSC Industrial Area. Other payload processing activities take place within facilities in the KSC Industrial Area and on CCAFS. In the future, life sciences payload processing will take place within the SERPL, located adjacent to the planned KSC International Space Research Park (ISRP).

- Space Station Processing Facility (SSPF)
- Operations and Checkout Facility (O&C)
- Vertical Processing Facility (VPF)
- Payload Hazardous Servicing Building (PHSF)
- Multi-Operation Support Building (MOSB)
- Spacecraft Assembly and Encapsulation Facility #2 (SAEF 2)
- Canister Rotation Facility (CRF)
- Spin Test Facility
- Hangar L
- Little L
- Space Experiments Research and Processing Laboratory (SERPL)

2.6.3 EXPENDABLE LAUNCH VEHICLE PROGRAM FACILITIES

The ELV Program Office at KSC provides the ELV launch services acquisition and management functions for NASA and its customers. These activities are carried out in facilities based in NASA facilities on CCAFB.

- E&O Building
- Launch Vehicle Data Center

2.6.4 TECHNOLOGY DEVELOPMENT FACILITIES

The complexity of electrical, mechanical, and biological systems support required at KSC demands unique computerized facilities. Specialized laboratories, personnel, and equipment provide resources for solving design and operational problems. A variety of facilities, launch systems, payload-processing facilities, and laboratories support diverse technology projects.

- Launch Equipment Test Facility (LETF)
- Robotics Applications Development Laboratory (RADL)
- Prototype Laboratory
- Artificial Intelligence Laboratory
- Microchemical Analysis Laboratory
- Biomedical Laboratory
- Non-Destructive Evaluation Laboratory (NDEL)

2.7 UTILITIES

2.7.1 REGULATORY OVERVIEW

2.7.1.1 Drinking Water. The Safe Drinking Water Act (SDWA) was established to protect the quality of drinking water and its sources (both surface and ground water). SDWA authorizes the Environmental Protection Agency (EPA) to establish standards and requires all owners and operators of public water systems to comply with these health-related standards. In August 1996, amendments to the SDWA were passed to tighten drinking water standards and provide funding to the states to improve water treatment systems. The objectives of the 1996 amendments focused on:

- Identification, monitoring, and control of drinking water contaminants as identified by EPA and SDWA
- Enforcement of the regulations
- Collection of treated water data and distribution to the public
- Providing consumer right-to-know information and
- Provide funding to the states for necessary treatment system upgrades

The legislature of Florida has enacted the "Florida Safe Drinking Water Act," Sections 403.850-403.864, F.S. This chapter and Chapters 62-550, 62-555, and 62-560, F.A.C., are promulgated to implement the requirements of the Florida Safe Drinking Water Act and to acquire and maintain primacy for Florida under the Federal Act. Under these laws, the State of Florida has delegated the Florida Department of Environmental Protection (FDEP) to promulgate regulations and administer programs for the enforcement of the State and Federal laws concerning our drinking water. FDEP has developed standards and operating practices to protect the health and safety of the public and is responsible for enforcing these regulations and permitting treatment and distribution systems.

The Safe Drinking Water Act gives EPA the responsibility for setting National drinking water standards that protect the health of the 250 million people, who get their water from public water systems. Since 1974, EPA has set National safety standards for over 80 contaminants that may occur in drinking water. While EPA and State Governments set and enforce standards, local Governments and private water suppliers have direct responsibility for the quality of the water that is delivered to the tap. The KSC water distribution system is maintained, tested, and treated to ensure that the quality of water delivered measures up to the Federal and State standards. These actions are continuously documented due to permitting and reported to the regulatory agencies governing the KSC Potable Water System.

2.7.1.2 Domestic Wastewater. The Florida Air and Water Pollution Control Act (FAWPCA) (Chapter 403 F.S.) of 1967 established State regulatory authority over wastewater treatment facilities. The directives of the FAWPCA were implemented through Chapters 62-3, 62-4, and 62-6 of the F.A.C. Chapters 62-3 and 62-4 F.A.C. deal with effluent quality standards and permitting requirements, respectively. Chapter 62-600 F.A.C. addresses wastewater facilities design and construction criteria. Under these laws, the State of Florida has delegated FDEP to promulgate regulations and administer programs for the enforcement of the State and Federal laws concerning the disposal of domestic wastewater. FDEP has developed the Domestic Wastewater Program to set treatment standards and operating practices to protect the health and safety of the public, to protect aquifers, lakes and rivers from harm, and to promote reuse of reclaimed water. FDEP and State Health Departments are responsible for enforcing these regulations and permitting treatment systems.

2.7.1.3 Industrial Wastewater. In an effort to restore and maintain the chemical, physical, and biological integrity of the Nation's waters, the Federal Government enacted the Federal Water Pollution Control Act, commonly known as the Clean Water Act (CWA) (amended 1977). The CWA gives EPA responsibility for regulating point source discharges of pollutants. The CWA also has provisions for State's to administer the Federal legislation after approval from EPA. Under these provisions, the State of Florida has enacted "The Florida Safe Drinking Water Act," Chapter 403, Florida Statute (F.S.), and "Water Resources," Chapter 373, F.S., to promote the conservation, replenishment, recapture, enhancement, development, and proper utilization of the State's water resources. These chapters and Chapter 62C-660, F.A.C., are promulgated to implement the requirements of the Florida Safe Drinking Water Act.

The State of Florida has delegated FDEP to promulgate regulations and administer programs for the enforcement of the State and Federal laws concerning the disposal of industrial wastewater. FDEP is responsible for issuing permits that authorize the discharge of properly treated wastewater to the land or to waters of the State. Due to the variability of waste streams, industrial waste treatment requirements must be developed on a case-by-case or industry-by-industry basis rather than under a uniform treatment standard, such as the minimum secondary treatment requirement for domestic wastewater facilities. Most industrial wastewater discharges are regulated by specific Federal requirements at a minimum. However, if additional treatment is necessary to protect Florida's water quality standards, the industries must provide it.

2.7.1.4 Consumptive Use Permitting. A Consumptive Use Permit (CUP) is required by the SJRWMD for each consumptive use of ground or surface water which:

- Exceeds more than 378,541 liters per day (100,000 gpd), annual average; or
- Is from a facility (wells, pumps, etc.) or facilities, which are capable of withdrawing 3.7 million liters (1,000,000,000 gallons) or more of water per day; or
- Is from a well with an outside diameter of the largest permanent water bearing casing is 15 cm (6 in) or greater.

All permits include certain limiting conditions set forth in Chapter 40C-2.381, F.A.C. SJRWMD prohibits significant adverse impacts on offsite land uses and legal uses of water existing at the time of permit application.

Permitting authority is granted to SJRWMD under Section 373.216, F.S. In so doing, the State is attempting to conserve and promote the proper utilization of Florida's ground and surface waters. KSC is located in the District's Upper St. Johns River Administrative Basin.

2.7.1.5 Stormwater. Rain is an inevitable part of living in Florida. Rainfall is soaked up by the soil, collected by streams, rivers, and ponds, and utilized by vegetation. However, as Florida becomes more developed and buildings, roads, and parking lots replace our natural areas we reduce the areas available to store rainfall. When this happens, the volume of rainfall that flows offsite increases and creates possible flooding issues in downstream areas. Rainfall runoff from parking lots, buildings, roads, and other manmade structures also collects a wide variety of pollutants such as grease and oils, nutrients, and suspended solids. These pollutants are carried offsite into rivers and streams to contaminate water sources used for drinking water, habitats for aquatic species, and recreational activities.

In an effort to conserve and protect our water and land resources, the Federal Government enacted the Rivers and Harbors Act of 1899, and the Federal Water Pollution Control Act, commonly known as the CWA. The Rivers and Harbors Act gives responsibility to the Army Corps of Engineers (COE) to regulate activities in the Nation's waterways, including the building of structures and all dredge and fill activities. The CWA gives responsibility for permitting dredge and fill activities to the COE and also to EPA. The CWA also has provisions for State's to administer the Federal legislation after approval from EPA. Under these provisions, the State of Florida has enacted "The Florida Safe Drinking Water Act," Chapter 403, F.S., and "Water Resources," Chapter 373, F.S., to promote the conservation, replenishment, recapture, enhancement, development, and proper utilization of the State's water resources. These chapters and Chapters 40C-4, 40C-42, 40C-44, and 40C-400, F.A.C., are promulgated to implement the requirements of the Florida Safe Drinking Water Act.

To manage the issues of flooding and water contamination, the State of Florida created a program that requires the construction of surface water management systems to control stormwater runoff. The Environmental Resource Permit (ERP) Program was developed with two main goals. The first is to ensure that any type of new development or changes in land use will not cause flooding by adversely affecting the natural flow and storage of water. The second purpose is to prevent stormwater pollution in lakes and streams and to protect wetland environments. This program is administered by the St. Johns River Water Management District and by FDEP. These two agencies are responsible for reviewing stormwater system designs and issuing permits for their construction and operation.

2.7.1.6 NPDES Stormwater. In October 2000, EPA authorized FDEP to implement the National Pollutant Discharge Elimination System (NPDES) Stormwater Permitting Program in the State of Florida (in all areas except Indian country lands). DEP's authority to assume delegation of the NPDES Program is set forth in Section 403.0885, F.S., and is undertaken pursuant to a Memorandum of Agreement with EPA. The NPDES Stormwater Program regulates point source discharges of stormwater into surface waters of the U.S./State. Regulated sources must obtain an NPDES stormwater permit and implement a Stormwater Management Plan that includes pollution prevention techniques to reduce contamination of stormwater runoff.

EPA developed the Federal NPDES Stormwater Permitting Program in two phases. Phase I, promulgated in 1990, addresses the sources of stormwater runoff with the greatest potential to degrade water quality. These sources include:

- "Medium" and "large" municipal separate storm sewer systems (MS4s) located in incorporated places and counties with populations of 100,000 or more, and

- Eleven categories of industrial activity, one of which is large construction activity that disturbs 2 or more ha (5 or more ac) of land.

Phase II, promulgated in 1999, addresses additional sources of concern, including certain "small" MS4s and small construction activity disturbing between 0.4 and 2 ha (1 and 5 ac), that must be permitted by March 10, 2003. Phase II also revised the Phase I industrial no exposure conditional exclusion to broaden its applicability.

The NPDES Stormwater Permitting Program is separate from the State's Stormwater and ERP Programs and local stormwater and water quality programs, which have their own regulations and permitting requirements.

2.7.2 KSC UTILITIES

2.7.2.1 Drinking Water. At KSC, we use tap water for a wide variety of purposes. Some of these are for personal use such as drinking, cooking, and bathing, while some purposes are for public activities such as lawn irrigation, fire fighting, air conditioning, and construction. Commercial and industrial operations also place heavy demands on the public water supply. These include launch operations such as sound suppression and deluge/wash operations, and shuttle and launch vehicle processing operations. KSC uses an average of 4.9 million liters per day (1.3 million gpd) with a maximum daily average usage of 8.3 million liters (2.2 million gal). It obtains this resource under a service contract with the City Of Cocoa, Florida, which provides for an estimated daily consumption of 9.4 million liters per day (2.5 million gpd) and an estimated daily maximum of 14.1 million liters per day (3.75 million gpd).

KSC is subject to regulation under the Safe Drinking Water Act as a supplier, since it operates a Non-Transient, Non-Community "Public Water System," as defined by State and Federal regulations. The source of KSC's drinking water supply is surface water from the Taylor Creek Reservoir and groundwater from wells located in east Orange County. The City of Cocoa operates the Claude H. Dyal Water Treatment Plant that treats the raw water from these sources. Water from this plant is transmitted to KSC via a 60 cm (24 in) water main to KSC's south boundary at Gate #2. At this interface point, the flow rate of water is maintained by boostered pumps at the Water Pump Station (N6-1007), while chlorine and a corrosion inhibitor are added to maintain the proper chlorine residual and integrity of the distribution system. Water flows through a 60 cm (24 in) primary distribution system from the South Gate to the VAB Area. At the intersection of Schwartz Road and S.R. 3, the water is again chlorinated to maintain the residual concentration. Throughout KSC there are various storage systems and secondary pump systems to supply water needs for fire suppression, launch activities, and potable water needs.

2.7.2.2 Domestic Wastewater. KSC maintains operating permits for two (2) domestic wastewater treatment facilities. These two facilities, STP-5 and STP-6, are small package plants that service LC-39A and B, respectively. Two collection/transmission systems, one located in the Industrial Area and one in the VAB Area, provide service for approximately 80 percent of NASA and contractor personnel at KSC. These systems transport raw wastewater to the CCAFS Regional Plant located on CCAFS. There are a number of septic tank systems throughout KSC that typically support small offices or temporary facilities. Of the existing septic tanks, only a few are permitted under Chapter 64E-6, F.A.C. The remaining septic tanks were constructed prior to the implementation of permitting regulations and are, therefore, grandfathered under these rules.

2.7.2.3 Industrial Wastewater. KSC currently maintains operating permits for five (5) facilities treating Industrial Wastewater (IWW).

Beach Corrosion Test Laboratory - The Beach Corrosion Test Laboratory is located near Complex 40 along the Atlantic Ocean. The facility is used for testing the resistance of materials and coatings to the natural elements. The IWW is generated when seawater is withdrawn from the ocean and passed over test materials before being discharged back to the ocean.

SRB Refurbishment Area - The SRB Refurbishment area is located in the Hangar AF area in CCAFS. The facility is used to disassemble and refurbish the Solid Rocket Boosters (SRBs) on a "per launch" frequency. The IWW is generated during the hydrolase process of removing coatings from SRBs. Hydrolasing involves the use of high-pressure water streams to blast material from the surfaces of SRBs. The wastewater generated by this process is filtered and treated on-site and reused in the hydrolase operations.

Launch Complex 39 – LC-39A and B utilize holding tanks to treat IWW waste streams generated by sound suppression water, firex water, SRB exhaust and post-launch wash down. The IWW generated during launch is collected in deluge tanks and is neutralized with sodium hydroxide or phosphoric acid. The effluent is discharged to a percolation pond using supplementary sprayfield disposal. The system is operated on a "per launch" basis. Diversion gates direct stormwater runoff to stormwater swales in non-launch configuration.

Visitors Center Bus Wash - The Bus Wash Recycle System is located at the Visitors Center at KSC. The IWW treatment system is a 100 percent closed-loop recycled wash water plant used for the cleaning of tour buses used by the Visitors Center. Make-up water is required to replace evaporation and carry-off only.

LICON Recycling System - The LICON Recycling System is located at the Component Refurbishment and Cleaning Area (CRCA) in the VAB Area of KSC. The LICON treats waste streams from component cleaning, an analytical lab, and a compressor discharge storage tank. The treatment system consists of an evaporator system and a UV/peroxidation system rated at 18 and 37 liters per minute (5 and 10 gpm), respectively. The design capacity is 18,927 liters per day (5,000 gpd). Treated effluent is reused in the testing laboratory. A wet concentrated residual is obtained, which is tested for hazardous characteristics and disposed of off-site.

2.7.2.4 Stormwater. KSC has over 100 surface water management systems to control stormwater runoff. The four largest stormwater systems at KSC are the Region I System that serves the Industrial Area, the Sub-basin 11 System that serves the western VAB Area, the VAB South System that serves the south VAB Area, and the SLF System that serves the SLF (see Figure 2-3).

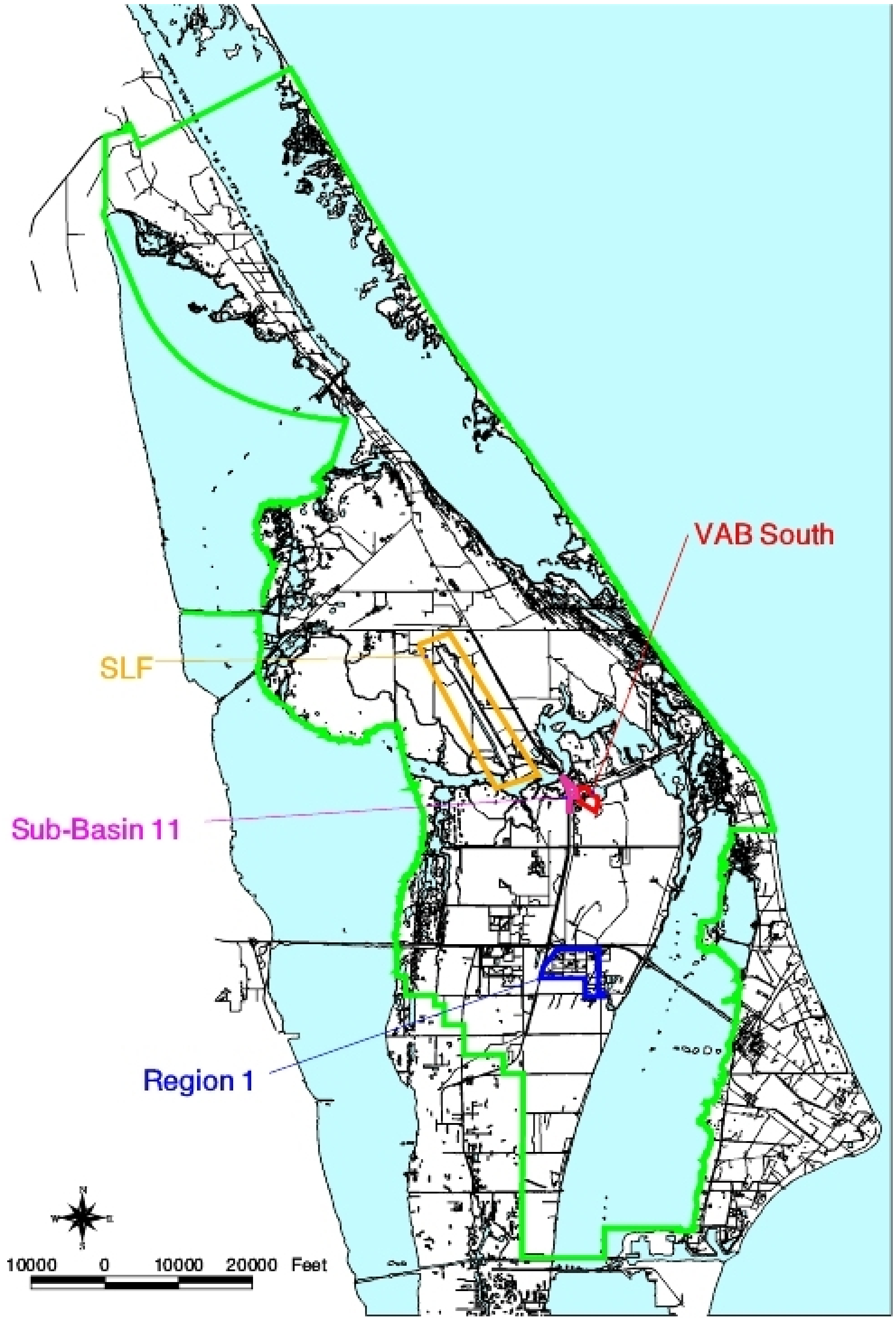

Figure 2-3. Regional Stormwater Systems at KSC.

2.7.2.5 NPDES Stormwater. In addition to those stormwater management systems permitted by the St. Johns River Water Management District, KSC manages an NPDES Stormwater permit for industrial activities. This permit covers six industrial operations at KSC, which includes the Contractors Road Locomotive Yard, the SLF, the Ransom Road Reclamation Yard, the TSD Facility, and the Fleet Maintenance Facility.

KSC does not meet the criteria established by FDEP that would categorize it as an urban area and is, therefore, not required to obtain a permit as an MS4s.

SECTION III

AIR RESOURCES

3.1 GENERAL

All of KSC's air sources are regulated under a single Title V Operating Permit, 0090051-006-AV.

3.2 AIR QUALITY

3.2.1 REGULATORY OVERVIEW

3.2.1.1 Federal Regulations. The Federal regulation of air pollution began with the Clean Air Act (CAA) (42 U.S.C. 7401-7642, Public Law 88-206, as amended), which has been amended several times since originally enacted in 1963. The most recent amendments were enacted in November 1990. Titles IV, V, and VI were added in the most recent amendments. The CAA authorizes EPA to adopt regulations for the control and abatement of air pollution. EPA regulations are contained in 40 Code of Federal Regulations (CFR) 50 through 87. As the CAA relates to KSC, the requirements of Titles I (including Title III of the 1990 CAA Amendments), V and VI are of primary concern.

Title I of the CAA is the basis for EPA's air quality and emission limitations, the Prevention of Significant Deterioration (PSD) Program, and the New Source Review (NSR) Program. Title I established requirements for the National Ambient Air Quality Standards (NAAQS), the Florida State Implementation Plan (SIP), the New Source Performance Standards (NSPS), the National Emission Standards for Hazardous Air Pollutants (NESHAP), as amended through Title III of the 1990 CAA Amendments, and the requirements for Federal facilities to comply with all Federal, State, and local air pollution regulations.

Title V established the Federal Operating Permit Program. The Federal operating permit replaces all previous State air pollution operating permits at KSC. In addition, this program establishes a Reporting Program and Fee Program based on emission levels. The program is delegated to the State of Florida and is administrated by the Florida Department of Environmental Protection (FDEP).

Title VI initiates the Federal Program related to the protection of the stratospheric ozone layer. The CAA mandates the phase out of production and consumption of Classes I and II substances, the initiation of recycling and emission reduction programs, the implementation of a Federal Procurement Program, and requires Federal facilities to comply with its requirements. Additionally, programs targeting the service of motor vehicle air conditioners and Halon emissions reduction are required.

Compliance with the NAAQS for an area is the primary objective of the regulations currently being developed and enforced by EPA and FDEP. KSC is located within an area, which is classified as attainment for all the pollutants listed in Table 3-1. This classification represents that pollutant concentrations within the KSC boundaries are below the NAAQS established standards by EPA. Additionally, this classification triggers the requirements of the PSD program versus the much more stringent requirements of the NSR Program.

Table 3-1. State and Federal Ambient Air Quality Standards.

Pollutant	Average Time	State of Florida Standard	Federal Primary Standard	Federal Secondary Standard
Carbon Monoxide	8-hour*	9 ppm (10 mg/m3)	9 ppm (10 mg/m3)	
	1-hour*	35 ppm (40 mg/m3)	35 ppm (40 mg/m3)	
Lead	Quarterly Arithmetic Mean	1.5 ug/m3	1.5 ug/m3	(same as primary)
Nitrogen Dioxide	Annual Arithmetic Mean	0.05 ppm (100 ug/m3)	0.053 ppm (100 ug/m3)	(same as primary)
Ozone	1-hour+	0.12 ppm (235 ug/m3)	0.12 ppm (235 ug/m3)	(same as primary)
	8-hour^	0.08 ppm (157 ug/m3)	0.08 ppm (157 ug/m3)**	(same as primary)
Sulfur Dioxide	Annual Arithmetic Mean	0.02 ppm (60 ug/m3)	0.03 ppm (80 ug/m3)	
	24-hour*	0.1 ppm (260 ug/m3)	0.14 ppm (365 ug/m3)	
	3-hour*	1300 ug/m3 (0.5 ppm)		1300 ug/m3 (0.50 ppm)
Inhalable Particulates (PM10)	Annual Arithmetic Mean	50 ug/m3	50 ug/m3	(same as primary)
	24-hour*	150 ug/m3	150 ug/m3	(same as primary)
Particulates (PM2.5)	Annual Arithmetic Mean		15 ug/m3**	(same as primary)
	24-hour		65 ug/m3**	(same as primary)
*Not to be exceeded more than once per year. (Parenthetical value is an approximately equivalent concentration.)				
+Not to be exceeded an average of more than one day per year.				
^Maximum 8-hour average concentration. Twenty-one days (70 percent) are required to yield a valid month. (%) – Percent of valid data for month.				
** The ozone 8-hour standard and the PM 2.5 standards are included for information only. A 1999 Federal court ruling blocked implementation of these standards, which EPA proposed in 1997. EPA has asked the U.S. Supreme Court to reconsider that decision.				
Source: Ref. 1.				

The CAA requires each State to develop and submit a State Implementation Plan (SIP) to EPA for approval. The purpose of the SIP is to provide a framework by which each State will ensure compliance with the NAAQS or achieve compliance within a reasonable time. The majority of the regulations adopted by FDEP are incorporated in Florida's SIP. This allows EPA to enforce these regulations, including the State requirements for construction and operating permits, should FDEP fail to do so.

The CAA requires EPA to identify source categories, which significantly contribute to air pollution, and to adopt regulations that reflect the best system of continuous emission reduction for new sources. This is the basis for the NSPS Program. EPA is expected to periodically re-examine the NSPS's and revise them, when necessary.

The CAA requires EPA to adopt regulations for the control of hazardous air pollutants (HAP) from both major and area sources through the application of the Maximum Achievable Control Technology (MACT) to major sources. The recent CAA amendments defined and listed 189 HAPs. The amendments also require case-by-case MACT determinations for any source for which EPA fails to adopt regulations. EPA has listed the source categories potentially subject to regulation under the NESHAP Program. The amendments also require EPA to develop an Accident Prevention Program to control the release of hazardous air pollutants. Section 112(r) of the CAA established the chemical accident prevention provisions. These regulations require facilities that manufacture, process, store, or handle regulated substances in amounts greater than threshold quantities to have a Risk Management Program (RMP). The RMP requirements have been delegated to the State level and are administrated by the Florida Department of Community Affairs.

The CAA requires EPA to address air pollution from new major stationary sources and major modifications to major stationary sources in both attainment and non-attainment areas. EPA has addressed this requirement through the PSD (attainment areas) and NSR (non-attainment areas) regulations and Title V operating permitting programs. A stationary source generally includes all pollutant-emitting activities, which are located on contiguous or adjacent properties, and are under common control. Implementation of these programs in Florida is through the SIP process. The CAA requires EPA to develop and implement a Federal Operating Permit Program or Title V Permit Program for all major stationary air pollution sources. The CAA also authorizes the collection of fees on an annual basis based on emission levels to pay for the program cost. This permitting process is different than the PSD and NSR permitting programs. Those programs require a one-time-only permit generally considered as a construction permit. The 1990 amendments have greatly expanded the requirements of the CAA, specifically in non-attainment areas, hazardous air pollutants, permits, and ozone depleting substances.

3.2.1.2 State Regulations. The state regulation of air pollution in Florida began with the "Florida Air and Water Pollution Control Act" and the "Florida Environmental Reorganization Act of 1975", (Environmental Control, Chapter 403, Florida Statutes). These laws established the FDEP and authorized the development and enforcement of air pollution regulations.

Florida regulations pertaining to air pollution are specified in the Florida Administrative Code (F.A.C.). The applicable chapters include: 62-2, 62-4, 62-200, 62-202, 62-204, 62-209, 62-210, 62-212, 62-213, 62-214, 62-242, 62-243, 62-244, 62-252, 62-256, 62-257, 62-272, 62-273, 62-275, 62-281, 62-296, and 62-297, F.A.C. The regulations applicable to KSC are summarized as follows:

Permits (Chapters 62-4, 62-210, 62-212, 62-213, F.A.C.) are required for all operations, which have the potential to emit air pollutants to the atmosphere. This includes state construction, PSD and NSR permits, and Title V operating permits. Section 62-4.040(1)(b), F.A.C., allows FDEP the discretion to exempt certain operations from the need for a permit on a case-by-case basis. Additionally, Section 62-210.300(3), F.A.C., lists operations for which FDEP does not require air pollution permits.

Ambient air quality standards and area designations are contained in Chapters 62-272 and 62-275, F.A.C. Within Florida, the NAAQS are incorporated as well as the more stringent Florida Ambient Air Quality Standards (FAAQS). The FAAQS are listed along with the NAAQS in Table 3-1.

Emission standards and monitoring requirements are specified in Chapters 62-296 and 62-297, F.A.C. The emission standards contain both general and specific requirements related to stationary sources, the NSPS Program, and the NESHAP Program.

Open burning regulations are contained in Chapter 62-256, F.A.C. FDEP and the Florida Department of Forestry are the primary agencies regulating open burning at KSC and the Merritt Island National Wildlife Refuge.

3.2.2 KSC TITLE V OPERATING PERMIT

On March 29, 1999, the FDEP-Central District issued KSC a final Title V operating permit (Permit No. 0090051-006-AV). The Title V operating permit is valid for a period of five (5) years and requires a renewal application to be submitted six (6) months prior to the date of expiration. Based on the initial Title V permit application received June 7, 1996, KSC is designated as a major source of HAPs and requires permitting. The emission units and/or activities are divided into three-types: permitted, unregulated, and insignificant. The permitted units are then divided into three-subsections: hot water generators, surface coating operations, and miscellaneous other operations. Table 3-2 summarizes the Title V emission units with the types of emission units, identification numbers, and limited pollutant, if any. The only units that have limitations for pollutants are surface coating operations; all other operations are not applicable to any limiting standard or work practice. This will limit the amount of any pollutant emitted. All of the emission units do, however, have usage rate limitations, which do limit the capacity of the unit and, therefore, limits the emissions. The usage rate limitations are discussed later. The permit also contains facility-wide conditions that must be complied with for the operations permit to be valid. These include, but are not limited to, visible emissions at KSC, which must be less than 20 percent opacity. KSC must comply with RMP regulations and procedures to minimize VOC emissions.

Table 3-2. KSC Title V Emission Units Summary.

Emission Unit Description	Emission Unit Identification Number	Internal Identification Number	Limited Pollutant
Permitted - Subsection B			
Vehicle Assembly Building Utility Annex Hot Water Generators (3)	001	IM-B-002 A, B, and C	Not Applicable
Central Heat Plant Hot Water Generators (3)	002	IM-B-001 A, B, and C	Not Applicable
Solid Rocket Booster Assembly and Refurbishment Facility Hot Water Generators (2)	013	SK-B-001 A and B	Not Applicable
Parachute Refurbishment Facility Hot Water Generator	051	SK-B-002	Not Applicable
Relocatable Hot Water Generators (3)	058	IM-B-006 A, B, and C	Not Applicable
Hanger AE, Hanger M, Hanger S Main, Hanger S South, and Hanger L Hot Water Generators (5)	077	IM-B-004 A, B, C, D, and E	Not Applicable
Permitted - Subsection C			
Isopropyl Alcohol Vent Hood	020	TM-H-002	Isopropyl Alcohol
Hanger AF East and West Paint Booths	042	SK-P-006	Volatile Organic Compounds
2 Drive Through Paint Booths, Corrosion Control Facility	069	IM-P-001	Volatile Organic Compounds
Top Coat Application Cell, Solid Rocket Booster Assembly and Refurbishment Facility	083	SK-P-001	Perchloro-ethylene
Thermal Protection System Spray Cells No. 1 and 2, Solid Rocket Booster Assembly and Refurbishment Facility	084	SK-P-004 A	Perchloro-ethylene
Thermal Protection System Cure Cells No.'s 1 and 2, Solid Rocket Booster Assembly and Refurbishment Facility	085	SK-P-004 B	Perchloro-ethylene
Permitted - Subsection D			
Kennedy Space Center-wide Diesel Fired Units	086	KSC-DE-001	Not Applicable
Kennedy Space Center-wide Gasoline Fired Units	087	KSC-GE-001	Not Applicable
Launch Complex-39 Emergency Power Plant (K6-1091)	088	IM-G-001	Not Applicable

Table 3-2. KSC Title V Emissions Units Summary (continued).

Unregulated			
Surface Coating Fume Hood	064	TM-P-002	Not Applicable
Surface Coating Fume Hood	066	TM-P-003	Not Applicable
Base Support Building Spray Booth (M6-486)	071	IM-P-002	Not Applicable
Natural Gas Compressors (2)	078	IM-C-001 A and B	Not Applicable
Kennedy Space Center-wide Fugitive Emissions	081	KSC-FUG-001	Not Applicable
Insignificant Units and/or Activities			
Auto Services	I-1	Not Applicable	Not Applicable
Battery Stations	I-2	Not Applicable	Not Applicable
Abrasive Blasting Operations	I-3	Not Applicable	Not Applicable
Can Puncturing Devices	I-4	Not Applicable	Not Applicable
Cleaning Operations	I-5	Not Applicable	Not Applicable
Mixing/Coating Operations	I-6	Not Applicable	Not Applicable
Flare Stacks	I-7	Not Applicable	Not Applicable
Local Exhaust Ventilations	I-8	Not Applicable	Not Applicable
Facility Support Systems	I-9	Not Applicable	Not Applicable
Hypergol Servicing Operations	I-10	Not Applicable	Not Applicable
Ovens/Dryers	I-11	Not Applicable	Not Applicable
Sewage/Wastewater Treatment	I-12	Not Applicable	Not Applicable
Storage Tanks	I-13	Not Applicable	Not Applicable
Vacuum Systems	I-14	Not Applicable	Not Applicable

All administrative, insignificant or minor modifications to the permit that occur before the renewal application are submitted must be proposed in a written letter with supporting information or calculations to FDEP for consideration. If FDEP concurs with the letter, the modification is automatic. If the desired modification or new source is major, then an application for an air construction permit must be submitted with a PSD determination included in the application. Once the construction and the compliance testing are complete, the new source or modification of the existing source is added to the Title V operating permit.

Requirements of the Title V operating permit include an Annual Operating Report, an annual operating fee, and an annual certification of compliance. A summary of the Annual Operating Report can be found in Table 3-3. The report, which is due to FDEP each March, calculates the actual emissions from all of the permitted and unregulated emission units. FDEP has developed a computer program for the Annual Report called the Electronic Annual Operating Report (EAOR). The reported emissions then become part of a database maintained by FDEP. The annual operating fee is also due each March to FDEP. The fee amount is based on the usage of the emission-limited units, of which KSC has five. The certification of compliance is submitted each March to FDEP and EPA. This is signed by the responsible person to certify that KSC has remained in compliance with the Title V permit requirements over the previous year. The level of KSC compliance is also documented.

Table 3-3. 2001 KSC Actual Emissions.
(Influencing Ambient Air Quality)

Air Pollutant	Quantity Emitted 2001 (tons/yr)	Quantity Emitted 2000 (tons/yr)
Criteria Pollutants		
Carbon Monoxide (CO)	39.60	46.88
Nitrogen Oxides (NO_x)	67.20	37.24
Particulate Matter (PM)	3.11	2.63
PM less than 10 microns (PM_{10})	3.01	2.63
Sulfur Dioxide (SO_2)	0.80	0.90
Lead (PB)	0	0
Volatile Organic Compounds (VOC)	7.88	7.80
Hazardous Air Pollutant (HAP)		
Total HAPs	2.22	2.19
Ethylene Glycol (H090)	0.029	0.029
Methyl Ethyl Ketone (H120)	1.28	1.27
Methyl Isobutyl Ketone (H123)	0.051	0.050
Perchloroethylene (H167)	6.11	3.78
Toluene (H169)	0.32	0.53
Xylenes (H186)	0.68	0.74
Source: KSC NASA 2001 Annual Operating Report		

3.2.2.1 Hot Water Generators. The hot water generator emission units are described in Subsection B of the KSC Title V operating permit. There are 15 hot water generators permitted within 6 emission units (EU). The hot water generators are located at: the Vehicle Assembly Building (VAB) Utility Annex (EU 001), which has three (3) units; the Central Heat Plant (EU 002), which has three (3) units; the Solid Rocket Booster-Assembly and Refurbishment Facility (SRB-ARF) (EU 013), which has two (2) units; the Parachute Refurbishment Facility (EU 51); Hanger AE, Hanger M Annex, Hanger S Main, Hanger S South, and Hanger L on Cape Canaveral Air Force Station (CCAFS) (EU 077); and three (3) relocatables (EU 058), that can be moved to where they are needed. Records are maintained at the location of the hot water generators for the fuel usage for all emission units. All hot water generators are permitted and have the capacity for fuel use of natural gas, Number 2 fuel oil, or propane. Natural gas is the primary fuel, because it produces fewer emissions.

Each emission unit has an annual fuel limitation based on a consecutive 12-month period. If there is not a specific fuel that is limited, the limitation for the specified fuel (Number 2 fuel oil, natural gas, or propane) can be converted to the fuel, which is used and recorded for consecutive 12 months using the annual heat input rate for the unit. In addition to the fuel limitations, there may be an operating capacity that is established for the heat input for an emission unit. The fuel limitations and operating capacities for the hot water generators are as follows: 5,223,868 liters (1,380,000 gallons) of Number 2 fuel oil or equivalent for natural gas or propane for EU 001; 1,703,435 liters (450,000 gallons) of Number 2 fuel oil or 7.13 cubic meters (252, 000 cubic feet) or equivalent for propane with the total combined heat input rate not to exceed 85 million British thermal units per hour (MMBtu/hr) for EU 002; 378,541 liters (100,000 gallons) of Number 2 fuel oil or 3.39 cubic meters (120, 000 cubic feet) of natural gas or equivalent for propane and a normal operating condition of 65 percent of the potential heat input of 21 MMBtu/hr on an annual basis for EU 013; 415 cubic meters (14,660 cubic feet) of natural gas or equivalent for natural gas or propane and a normal operating condition of 40 percent of the potential heat input of 4.184 MMBtu/hr on an annual basis for EU 051; 543,585 liters (143,600 gallons) of Number 2 fuel oil or equivalent for natural gas or propane for EU 077; and 1,514,165 liters (400,000 gallons) of Number 2 fuel oil or equivalent for natural gas or propane for EU 058. The annual usage, hours of operation, and emissions are reported to FDEP using the EAOR each year for all of the units in this subsection. In 2001, KSC and CCAFS heating units used a total of approximately 8.49 cubic meters (300 million cubic feet) of natural gas and 68,137 liters (18,000 gallons) of Number 2 fuel oil in all the units combined.

The Industrial Area Central Heat Plant, SRB-ARF Heat Plant, and the VAB Annex Heat Plant represent approximately 70 percent of the heat plant capacity at KSC. The Industrial Area Central Heat Plant utilizes three heating units, two with 35 MMBTU/hr (heat input rate) unit capacity, and one 16 MMBTU/hr capacity. The two SRB-ARF Heat Plant units are 21 MMBTU/hr. The three VAB Annex Heat Plant units are 25 MMBTU/hr. Typical heat plant operations utilize one to two heat units full time and another heat unit, part time, as peak loads demand. In addition, one heat unit at each facility functions as a backup for those periods when the others are taken out for service or repairs.

3.2.2.2 Surface Coating Operations. The surface coating operations emission units are found in Subsection C of the KSC Title V operating permit. There are a total of 10 units that are permitted within 6 emission units. The surface coating operations are as follows: an isopropyl alcohol (IPA) vent hood at Building K6-1696 (EU 020), east and west paint booths at Hanger AF at the CCAFS (EU 042), two drive-through paint booths at the Corrosion Control Facility (CCF) (EU 069), top coat application cell at the SRB-ARF (EU 083), Thermal Protection System (TPS) spray cells Numbers 1 and 2 at the SRB-ARF (EU 084), and TPS cure cells Numbers 1 and 2 at the SRB-ARF (EU 085). Records are maintained for the usage of all solvents and coatings used in any of the surface coating operations at all of these emission units.

Each emission unit has an annual coating and solvent usage limitation based on a consecutive 12-month period. In addition to the coating and solvent limitation, there are emission limitation placed on each of the emission units. The usage and emission limitation for the surface coating operations are as follows: 5,299 liters (1,400 gallons) of isopropyl alcohol usage and 5.41 tons IPA emissions per consecutive 12 months for EU 020; 9,842 liters (2,600 gallons) of coatings and solvent usage and 5.6 tons VOC emissions per consecutive 12 months for EU 042; 88,578 liters (23,400 gallons) of coatings and solvent usage and 58.0 tons VOC emissions per consecutive 12 months for EU 069; 7,192 liters (1,900 gallons) of coatings and solvent usage and 9.5 tons perchloroethylene emissions per consecutive 12 months for EU 083; and 5,408 liters (1,450 gallons) of coatings and solvent usage and 7.25 tons perchloroethylene emissions per consecutive 12 months for EU 084 and EU 085. The annual usage, hours of operation, and emissions are reported to FDEP using the EAOR each year for all of the units in this subsection. In 2001, KSC surface coating operations used a total of approximately 12,113 liters (3,200 gallons) of coatings and solvents in all the units combined and 689 kilograms (1,520 pounds) of IPA in EU 020.

KSC employs a variety of activities that result in emissions of VOCs and HAPs. These emissions are directly related to the types and quantities of the products utilized. Chemical tanks and trays are housed in multiple locations for purposes of cleaning, etching and coating metal parts. Spray, hand painting, and touchup applications are also performed in many locations. SRB assembly and refurbishment operations are responsible for producing the majority of total VOC emissions at KSC. SRB assembly and refurbishment operations involve cleaning, surface preparation, painting, and thermal coating applications. This includes the surface preparation activities performed in Hangar AF on CCAFS. Although the SRB-ARF is permitted to process 24 SRB motors per year, no more than 20 SRB motors have actually been processed in any year.

3.2.2.3 Miscellaneous Emission Units. The miscellaneous other emission units are found in Subsection D of the KSC Title V operating permit. There is one stationary generator unit and many relocatable and portable generator units that are permitted within three emission units. The miscellaneous operations are as follows: KSC-wide diesel fired units (EU 086), KSC-wide gasoline fired units (EU 087), and the Launch Complex 39 Emergency Power Plant in Building K6-1091 (EU 088). Fuel usage records are maintained for all of the units included in EU 086 and EU 087 by totaling the diesel (EU 086) and gasoline (EU 087) delivered to KSC for use in these permitted units over a consecutive 12-month period. It is assumed that the fuel that is delivered equals the amount used by the units. For EU 088, records are maintained for both fuel and hours of operation usage. EU 088 consists of five two-megawatt diesel generators that are used at KSC as emergency power for the Launch Complex 39 Area. Florida Power and Light (FPL) was involved in the construction of the facility and has the capacity to access the generators for emergency power.

Each emission unit has an annual fuel usage limitation based on a consecutive 12-month period. In addition to the fuel limitations set on EU 088, there is a limit placed on the hours of operation per consecutive 12-month period. The total combined generator units fuel usage and hours of operation limitations for the miscellaneous operations are as follows: 1,154,551 liters (305,000 gallons) of Number 2 fuel oil usage with a maximum sulfur content of 0.05 percent, by weight per consecutive 12 months for EU 086; 143,845 liters (38,000 gallons) of gasoline usage per consecutive 12 months for EU 087; and 643,520 liters (170,000 gallons) of Number 2 fuel oil usage with a maximum sulfur content of 0.05 percent, by weight and operations of 1,250 hours per consecutive 12 months for EU 088. The annual usage, hours of operation, and emissions are reported to FDEP using the EAOR each year for all of the units in this subsection. In 2001, KSC and CCAFS generator units used a total of approximately 20,819 liters (5,500 gallons) of gasoline and 908,498 liters (240,000 gallons) of Number 2 fuel oil in all the units combined.

3.2.2.4 Unregulated Emission Units. Unregulated emission units are defined in Appendix U-1 of the KSC Title V operating permit. Unregulated emission units are over the threshold for insignificant units or activities, but emit no "emissions-limited pollutant" and are subject to no unit-specific work practice standard. The emission units may still be subject to regulations applies on a facility-wide basis, such as unconfined emissions, odor, or general opacity regulations, or to regulations that require only that it be able to prove exemption from unit-specific emissions or work practice standards. The unregulated emission units are as follows: a surface coating fume hood in the Orbiter Processing Facilities (OPF) 1 and 2 (EU 064), a surface coating fume hood in OPF 3 (EU 066), spray booth at the Base Support Building, M6-486 (EU 071), two natural gas compressors (EU 078), and the emissions from fugitive sources (EU 081). These units have no limitations for usage, hours of operations, or emissions, but this information is reported to FDEP as part of the EAOR, with the exception of EU 081, which has no reporting requirements. In 2001, KSC unregulated units used a total of approximately 170 liters (45 gallons) of coatings and solvents in EU 064, EU 066, and EU 071, combined, and 110,000 cubic feet of natural gas in EU 078.

3.2.2.5 Insignificant Emission Units and/or Activities. The insignificant emission units and/or activities are described in Appendix I-1 of the KSC Title V operating permit. Insignificant emission units and/or activities are facilities, emission units, and/or pollutant-emitting activities, that are exempt from permitting requirements, because the potential emissions from the units and/or activities are below the threshold amounts or they are listed as a categorical exemption in F.A.C. Rule 62-210.300(3)(a). The thresholds found in F.A.C. Rule 62-213.430(6)(b) for insignificant units or activities to emit or have the potential to emit are: less than 226 kilograms (500 pounds) per year of lead and lead compounds, less than 453 kilograms (1,000 pounds) per year of any individual HAP, less than 1,133 kilograms (2,500 pounds) per year of the total HAPs, or 5 tons per year of any other regulated pollutant.

All emission units and/or activities have been classified by categories instead of listing individual sources. The insignificant emission units and/or activities are as follows: auto services, battery stations, abrasive blasting operations, can puncturing devices, cleaning operations, mixing/coating operations, flare stacks, local exhaust ventilations, facility support systems, hypergol servicing operations, ovens/dryers, sewage/wastewater treatment, storage tanks, and vacuum systems. Remediation activities are currently being evaluated so that this category may be added to the insignificant list. These units have no limitations for usage, hours of operations, or emissions, and the information is not required to be maintained or reported to FDEP.

3.2.3 OZONE DEPLETING SUBSTANCES

The Clean Act Air Amendments (CAAA) established a 2000 deadline for the phase-out of the production of the Class I Ozone Depleting Substances (ODS) chlorofluorocarbons (CFCs), halons, and carbon tetrachloride and 2002 for methyl chloroform. In 1992, these deadlines were accelerated in response to scientific findings that significant ozone depletion is underway in the Northern Hemisphere. The accelerated schedule required the phase-out of Class I ODCs by December 31, 1995. Also in 1992, the U.S. and other parties to the Montreal Protocol agreed to accelerate the phase-out of CFCs, carbon tetrachloride, and methyl chloroform to the end of 1995 and halons to the end of 1993. Under the Montreal Protocol, the U.S. must also phase-out its use of Class II ODCs (hydrochlorofluorocarbons or HCFCs) by 2030.

In 1993, EO 12843 directed Federal agencies to minimize the procurement of products containing Ozone-Depleting Substances (ODS). NASA issued NPG 8820.3 in response to the EO. The NASA policy requires that NASA minimize the procurement of ODS in anticipation of phasing out production. In April 2000, EO 13148 was issued and directs Federal agencies to develop a plan by April 2001, to phase out the procurement of Class I ODS for all non-excepted uses by December 31, 2010.

EO 13148 also requires Federal agencies to ensure that its facilities: (1) maximize the use of safe alternatives to ODS, as approved by EPA's Significant New Alternatives Policy (SNAP) Program; (2) evaluate the present and future uses of ODS, including making assessments of existing and future needs for such materials, and evaluate use of, and plans for recycling, refrigerants, and halons; and (3) exercise leadership, develop exemplary practices, and disseminate information on successful efforts in phasing out ODS.

Halons have a special use at KSC with the Shuttle Program. Halon is the only effective fire suppressant for the fuels used in the orbiter and has received EPA’s approval for an exemption. Because of this, NASA has set up a “Halon Bank” at KSC. In order to stockpile and prolong the procurement of halon, KSC has been designated as the collection center for all unused halon from all NASA centers.

3.2.4 RISK MANAGEMENT PROGRAM

The CAA, Section 112(r), places a general duty on the owners and operators of stationary sources producing, processing, handling, or storing any extremely hazardous substance, or any substance listed pursuant to Section 112(r) to: (1) identify hazards that may result from accidental releases; (2) design and maintain a safe facility; and (3) minimize the consequences of releases.

NASA/KSC is led by the guiding principle: “Safety and Health First.” The OSHA Process Safety Management (PSM) Program has been developed throughout KSC to minimize the potential for fires, explosions, and accidental releases of highly hazardous, toxic, flammable, reactive, or explosive chemicals. The program achieves this goal by taking a comprehensive approach, which involves integrating technologies, procedures, and management practices. All processes at KSC that include hazardous chemicals, regardless of the quantity or applicability to the RMP List Rule, are subject to the general duty clause of the RMP rule. EPA delegated authority to the State of Florida Department of Community Affairs to administer the RMP regulations.

RMP refers to 40 CFR 68, “Chemical Accident Prevention Provisions.” This section states that companies that manufacture, process, store, or handle regulated substances in amounts greater than threshold quantities are required to comply with these regulations by June 21, 1999. All decisions relating to this activity are based on EPA’s lists of regulated flammable substances and regulated toxic substances and their corresponding threshold quantities. In addition, facilities must be aware of the General Duty Clause of the CAA, which addresses all hazardous substances, regardless of the threshold amount.

The original NASA/KSC RMP was submitted June 7, 1999. Since the original RMP submittal, EPA sent a letter entitled, “Important Notice: Users and Retailers of Flammable Fuels,” dated March 15, 2000, revising the regulation to omit flammable fuels used or sold as fuel. This affects the status of the submitted RMP and a revision was submitted on June 21, 2000. The reporting status development is based on two recent events: the Chemical Safety Information, Site Security and Fuels Regulatory Relief Act (Public Law 106-40) signed on August 5, 1999, and the lifting of the court-ordered stay for propane on January 5, 2000. The revised RMP is similar to the originally submitted one with the exception of liquid hydrogen (LH_2) and propane, as listed substances and left only monomethyl hydrazine (MMH) as a listed substance at KSC.

The latest version of the RMP, submitted May 13, 2002, was a revision to lift the administrative controls currently in place, to limit the amount of MMH stored at Fuel Storage Area #1 (FSA-1) to less than the threshold value of 6803 kilograms (15,000 pounds), and will allow storage of full tankers at FSA-1. Modifications have been made to Facility 77800, which constructed two tanker storage bays with passive mitigation systems to limit the pool size of a worst-case spill from a full MMH tanker. The modifications were completed to accept the parking and storage of 2500-gallon DOT MC-338 (exempted tankers) that has an access ramp to provide containment of 100 square-meters (1,083 square-feet) and allow drainage into the facility’s covered sump.

3.2.5 NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS

The CAAA requires EPA to regulate emissions of toxic air pollutants from a published list of industrial sources referred to as "source categories" by promulgating the NESHAP. As required under the CAAA, EPA has developed a list of source categories that must meet control technology requirements for these toxic air pollutants. EPA is required to develop regulations or rules for all industries that emit one or more of the HAPs in significant quantities. Currently, KSC is applicable to only one promulgated source category in the NESHAP. KSC is exempt from following the MACT standards of the Aerospace NESHAP. As new proposed and promulgated NESHAPs are published in the Federal Register, applicability and impact analysis are preformed to determine the optimal approach to comply with the regulations.

Section 112(j) of the CAAA requires operators of major sources within a listed source category to apply for a Title V permit or renew the current Title V permit should EPA fail to promulgate emission standards for that source category by the date specified in the regulatory schedule established through Section 112(e) of the CAAA. The Title V permit that is issued must require the major source's ability to achieve a maximum achievable control technology (MACT) emission limitation for all HAP emissions. Regulations to implement Section 112(j) will be published in 40 CFR Part 63, Subpart B. EPA has delegated the permitting authority to the FDEP for complying with these regulations by identifying and evaluating control technology options to determine the MACT emission limitation. In April of 2002, FDEP requested that a Part 1 Notification Submittal for a MACT Determination be completed as required under 40 CFR 63.52 for stationary sources located on facilities, that are major sources of HAPs for which EPA failed to finalize a MACT Standard by May 15, 2002. KSC informed FDEP and EPA that it is a major source of HAPs and is required to submit this notification.

The notification information consists of the name, address, and brief description of KSC; an identification of the relevant industry-type source categories applicable to KSC when the final regulation is promulgated; a list of the emission units, sources, processes, and/or activities that belong to the relevant industry-type source categories; and an identification of any affected sources for which Section 112(g) MACT determination has already been made, which is none in the case of KSC. Of the over 40-affected industry-type source categories, KSC submitted information on 8 categories: Industrial, Commercial and Institutional Boilers and Indirect-Fired Process Heaters, Miscellaneous Metal Parts and Products (Surface Coating), Organic Liquids Distribution (non-gasoline), Paint Stripping Operations, Plastic Parts (Surface Coating), Reciprocating Internal Combustion Engines (RICE), Site Remediation, and Large Appliance (Surface Coating). The list of the emission units, sources, processes, and/or activities included permitted emission units, insignificant activities, or general KSC operations that are possibly affected activities. In the description of the categories, a statement was made if there is a possibility that KSC could be exempt, below a threshold amount, or not applicable to the final regulated NESHAP.

According to Section 112(j), EPA now has until May 15, 2004, to promulgate the outstanding NESHAPs. EPA fully expects to complete the promulgation of the rest of the NESHAPs, which would make Part 2 application obsolete. If they do not, on May 15, 2004, a Part 2 application will be due for any remaining unpromulgated NESHAP. The Part 2 application process will require more detailed information to be submitted, which includes a case-by-case MACT determination. The 112(j) Part 1 Notification Submittal for KSC was submitted on May 14, 2002.

KSC must also comply with the Asbestos NESHAP (Subpart M) and the FDEP regulations covered by F.A.C. 62-257 for notification of asbestos renovation or demolition. KSC must quantify all planned asbestos abatement projects in an annual notification submittal, if the total of all projects exceeds the threshold of at least 79 linear meters (260 linear feet) on pipes, at least 14 square meters (160 square feet) on other facility components, or at least 0.99 cubic meters (35 cubic feet) of facility components where the length or area could not be measured. KSC must also report all demolition of any load-supporting structural member using the same FDEP Form 62-257.900(1). This requirement is mandatory, whether the project contains regulated asbestos-containing material (RACM) or not, and regardless of any threshold amount. All unplanned asbestos abatement projects must also be reported using the same process, 10 days prior to exceeding the threshold quantity of RACM.

3.3 KSC AMBIENT AIR QUALITY

Ambient air quality at KSC is influenced by NASA operations, land management practices, vehicle traffic, and emission sources outside of KSC. Daily air quality conditions are most influenced by vehicle traffic, utilities fuel combustion, standard refurbishment and maintenance operations, and wildfires and controlled burning operations. Air quality at KSC is also influenced by emissions from two regional power plants, which are located within a 16.1 km (10 mi) radius of KSC. Space launches and vegetation fuel load reduction controlled burns influence air quality as episodic events. One of the most influential air quality fluctuations on a routine basis is created by the emissions from automobiles entering and departing KSC each day. Mobile sources and the control of the emissions are regulated under Title II of the CAA, but the regulations have no applicability to the environmental requirements of KSC. A summary of air source emissions from KSC is provided in Table 3-3. These calculations are based on emission factors in EPA's AP-42 Manual.

Ambient air quality at KSC is monitored at one Permanent Air Monitoring System (PAMS) station. PAMS A is located approximately 0.4 km (0.25 mi) southeast of the Environmental Health Facility site and approximately 1.6 km (1.0 mi) north of the KSC Headquarters Building (see Figure 3-1).

PAMS A includes continuous analyzers for monitoring sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), total inhalable (10-micron) particulates and a meteorological tower with instrumentation for wind speed, wind direction, high and low temperature, and relative humidity (Ref. 2).

A summary of air quality parameters collected from the PAMS A facility from October 2001 through September 2002 is provided in Table 3-4. There were no exceedances of either the primary or secondary air quality standards for O_3, CO, NO_2, or SO_2 for the entire year. The maximum hourly average value for O_3 was 75 ppb and it occurred in April 2002. The maximum 8-hour average value for O_3 was 48.9 ppb and it occurred in April 2002. The maximum 24-hour average value for SO_2 was 8.8 ppb, which occurred in October 2001. The maximum hourly average value for NO_2 was 29.1 ppb, which occurred in October 2001. The maximum hourly average value for CO was 6.9 ppm, which occurred in March 2002. PM-10 or PM-2.5 particulates were not monitored within the last year.

The maximum hourly value for the last 12 months was 75 ppb in April 2002. The maximum O_3 value occurring in April is typical when the "Bermuda High" sets up a stagnant weather condition. The maximum CO level was probably the result of either the use of a portable generator, a vehicle motor running in the area, or Center-wide controlled burns. NO_2 and SO_2 emissions are related to utilities fuel combustion and mobile sources. Strong correlation between elevated NO_2 and SO_2 levels and prevailing westerly winds suggest that power plants to the west of KSC could be the primary source of these emissions (Ref. 3).

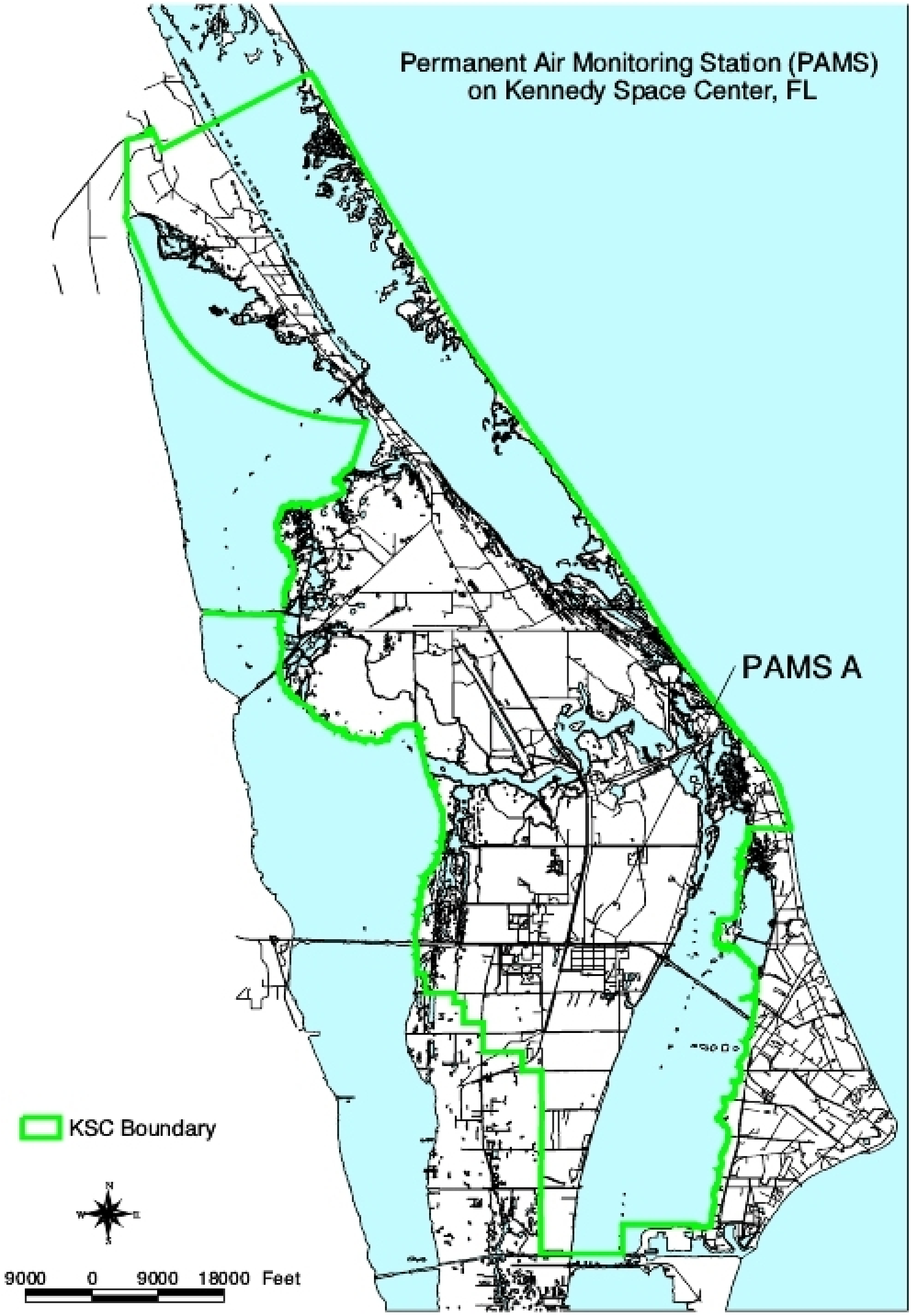

Figure 3-1. Permanent Air Monitoring Station.

Table 3-4. KSC Air Quality Data Summary PAMS A, 2002.

Parameter	**Federal [4] and State Standard**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**
Ozone (ppb)	Primary 80 (8-HR) [1]** Secondary 120 (1-HR-AVG)	31.4 40 (83.2%)	40.8 45 (98.1%)	44.4 47 (99.9%)	48.7 75.3 (97.5%)	46.0 54.9 (90.5%)	42.1 54.5 (78.9%)
Sulfur Dioxide (ppb)	Primary 140 (24-HR) [2,4] Secondary 500 (3-HR) [3]	3.6 5.1 (86.8%)	3.5 3.4 (99.4%)	3.9 3.8 (99.5%)	2.7 3.1 (97.5%)	2.7 2.8 (89.4%)	2.9 3.3 (99.0%)
Nitrogen Dioxide (ppb)	(1 HR-AVG) 50 (Annual-AVG) [3]	24.1 2.5 (76.1%)	14.5 2.8 (83.8%)	13.3 3.0 (99.7%)	19.8 3.3 (96.3%)	4.8 3.3 (51.1%)	9.0 3.3 (87.9%)
Carbon Monoxide (ppm)	35 (HR-AVG) [1] 9 (8-HR) [2]	1.0 0.6 (86.8%)	0.3 0.3 (99.3%)	6.9 1.3 (99.7%)	0.7 0.4 (97.5%)	0.7 0.3 (90.5%)	0.7 0.45 (99.0%)
Parameter	Federal [4] and State Standard	Jul	Aug	Sept	Oct	Nov	Dec
Ozone (ppb)	Primary 80 (8-HR) [1]** Secondary 120 (HR-AVG) [1]	41.5 52.5 (84.8%)	27.0 35.7 63.4%	24.7 40.1 (72.5%)	37.3 39.8 (98.5%)	48.9 55.3 (99.9%)	32.4 42 (99.6%)
Sulfur Dioxide (ppb)	Primary 140 (24-HR) [2, 4] Secondary 500 (3-HR) [3]	2.7 2.9 (99.2%)	3.2 3.6 (80.2%)	4.2 4.0 (72.8%)	8.8 9.1 (96.9%)	3.0 3.4 (99.0%)	2.9 3.4 (98.8%)
Nitrogen Dioxide (ppb)	(1 HR-AVG) 50 (Annual-AVG) [3]	17.2 3.3 (98.4%)	13.5 3.2 (80.4%)	11.7 3.2 (79.3%)	29.1 0.2 (77.8%)	9.3 0.2 (93.9%)	18.7 1.5 (94.5%)
Carbon Monoxide	35 (HR-AVG) [1] 9 (8-HR) [2]	0.6 0.4 (99.5%)	9.3 1.5 (80.1%)	0.6 0.4 (79.3%)	0.7 0.9 (98.5%)	0.9 0.3 (99.7%)	0.6 0.4 (99.7%)

[1] Maximum hourly average concentration (not to be exceeded more than once per year).
[2] Maximum time-period average concentration (not to be exceeded more than once per year).
[3] Annual arithmetic mean.
[4] Federal and State standards are identical except for SO_2; State Primary (24-hour) is 100 ppb.
NOTE:
** The ozone 8-hour standard and the PM 2.5 standards are included for information only. A 1999 Federal court ruling blocked implementation of these standards, which EPA proposed in 1997. EPA has asked the U.S. Supreme Court to reconsider that decision.
Twenty-one days are required to yield a valid month.
(%) = Percentage of validation the month.

SOURCES: References 4, 5, 6, and 7.

3.3.1 OZONE

Ozone is the most consistently "elevated" criteria pollutant at KSC (Ref. 2). Ozone is formed in a series of chemical reactions between oxidant precursors such as VOCs and NO_x in the presence of sunlight (Ref. 8). Local sources, as well as distant metropolitan areas can contribute to elevated ozone levels. Ozone precursors generated over land are directed offshore by prevailing evening winds. Morning sunlight catalyzes the conversion to ozone and onshore breezes can return ozone to the land mass. There have been six exceedances of the primary and/or secondary ambient air quality standards for O_3 recorded at KSC since 1988. However, the levels have been below these standards for the last 10 years.

Figure 3-2 displays a plot of the maximum monthly 8-hr and 1-hr O_3 values from October 2001 to September 2002, and the last 10-year means for comparison. The 1-hr data was below the associated 10-year mean for most of the year with the exception of November 2001 and April 2002. This is consistent with the “typical” bi-annual peaks found with ozone. The 75 ppb (0.075 ppm) in April 2002 was 62.5 percent of the 1-hr standard of 120 ppb (0.120 ppm). The 8-hr monthly values were below the 10-year mean all year with the exception of November 2001, with a value of 48.9 ppb (0.0489 ppm), which was 65.2 percent of the proposed 8-hr standard of 75 ppb (0.075 ppm).

3.3.2 SULFUR DIOXIDE

Figure 3-3 displays a plot of the maximum monthly 24-hr and 3-hr mean SO_2 values from October 2001 to September 2002, and the last 10-year means for comparison. The 24-hr data was above and below the associated 10-year mean for 6 months each of the year. The months being higher than the 10-year mean were October 2001, January, February, March, August, and September 2002. The highest 24-hr average was 8.8 ppb in October 2001, which was 6.3 percent of the primary standard of 140 ppb. The 3-hr values were above the 10-year mean in two months: October 2001 and January 2002. The highest 3-hr average was 9.1 ppb in October 2001, which was 1.8 percent of the primary standard of 500 ppb.

3.3.3 NITROGEN DIOXIDE

Figure 3-4 displays a plot of the maximum monthly annual average and the 1-hr NO_2 values from October 2001 to September 2002, and the last 10-year means for comparison. The annual average values were above the 10-year mean for all of the year except for October and November 2001. The highest annual average value was 3.3 ppb for April, May, June, and July 2002, which was 6.6 percentage of the standard of 50 ppb (100 ug/m3). The 1-hr data was at or above the associated 10-year mean for most of the year with the exception of May and June 2002. The highest 1-hr NO_2 value was 29.1 ppb in October 2001.

3.3.4 CARBON MONOXIDE

Figure 3-5 displays a plot of the maximum monthly 1-hr and 8-hr CO values from October 2001 to September 2002, and the last 10-year means for comparison. The 1-hr data was below the

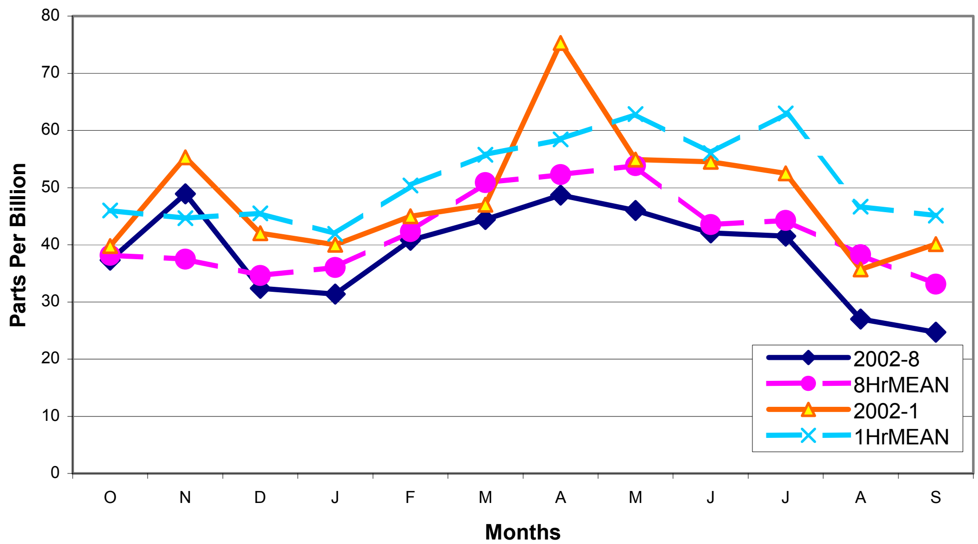

Figure 3-2. October 2001-September 2002 vs. 10-Year Mean for Ozone.

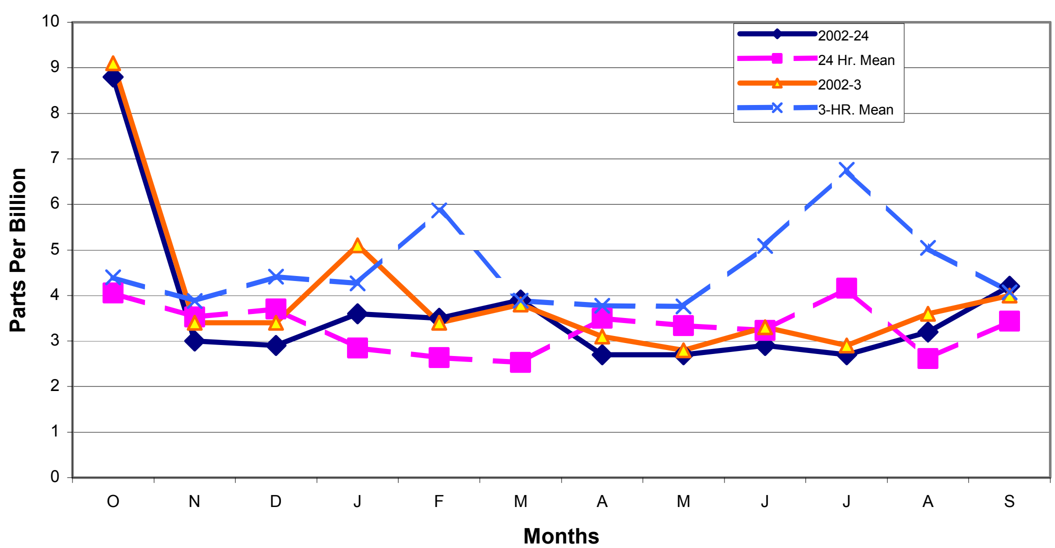

Figure 3-3. October 2001-September 2002 vs. 10-Year Mean for Sulfur Dioxide.

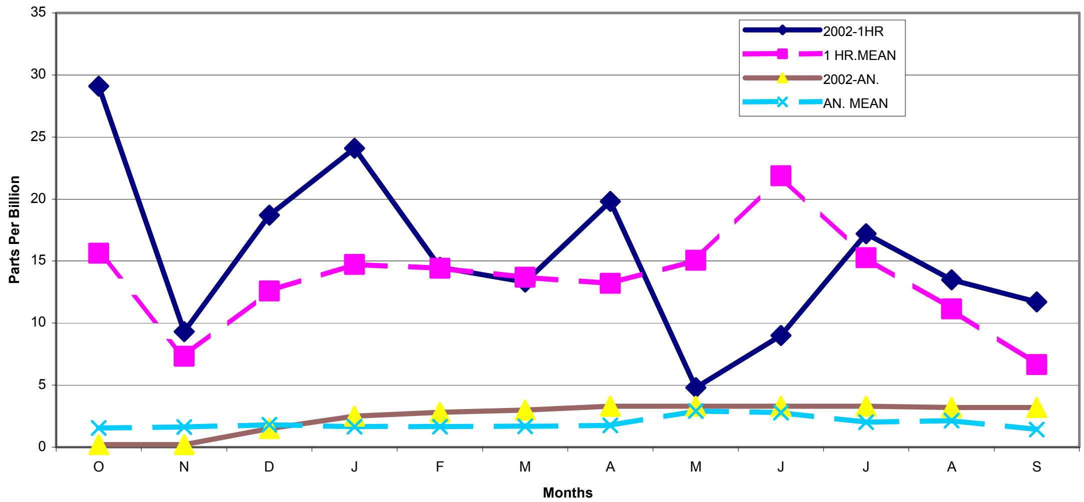

Figure 3-4. October 2001-September 2002 vs. 10-Year Mean for Nitrogen Dioxide.

associated 10-year mean for most of the year with the exception of March 2002. The highest 1-hr average of 6.9 ppm in March 2002 was 19.7 percent of the primary 1-hr standard of 35 ppm. The 8-hr monthly values were below the 10-year mean all year with the exception of October 2001 and March 2002. The highest 8-hr value of 1.3 ppm occurred in March 2002 and was 14.4 percent of the proposed 8-hr standard of 9.0 ppm.

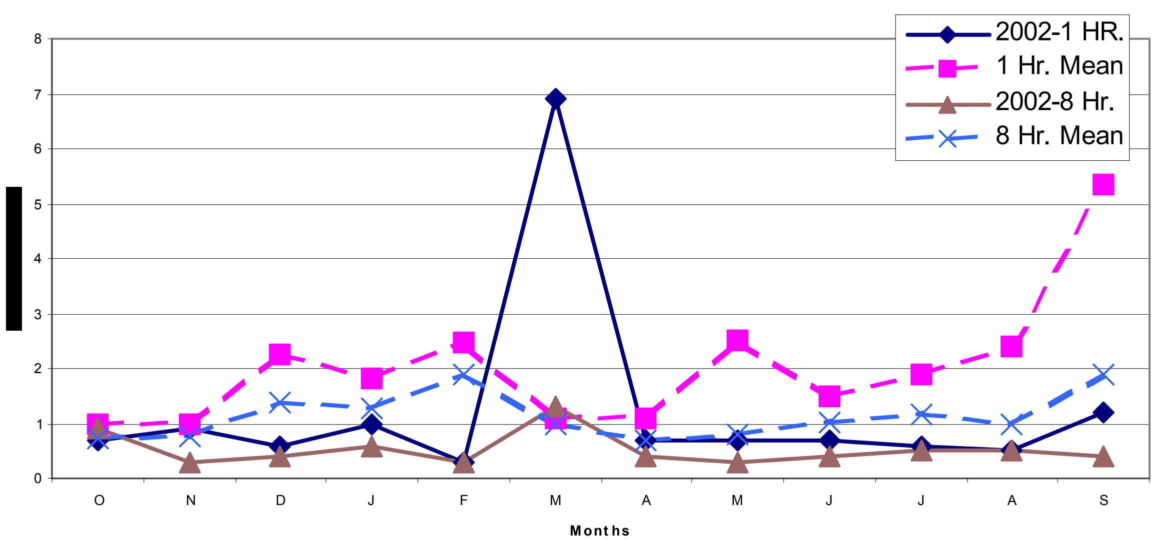

Figure 3-5. October 2001-September 2002 vs. 10-Year Mean for Carbon Monoxide.

3.4 CLIMATIC CONDITIONS

The climate of KSC is subtropical with short, mild winters and hot, humid summers, with no recognizable spring or fall seasons. Summer weather, usually beginning in April, prevails for about 9 months of the year. Typically, dawns are slightly cloudy or hazy, with little wind and temperatures near 70 degrees Fahrenheit (F). During the day the temperature rises into the 80s and 90s F. A typical day is mostly sunny with scattered white clouds. Often dark clouds in the afternoon foreshadow a storm. Thundershowers frequently lower local temperatures and an ocean breeze usually appears. Occasional cool days occur in November, but winter weather starts in January and extends through February and March. These last two months are usually windy and temperatures range from about 40^{o}F at night to 75^{o}F during the daytime (Ref. 9). The dominant weather pattern (May to October) is characterized by southeast winds, which travel clockwise around the Bermuda High. The southeast wind brings moisture and warm air, which help produce almost daily thundershowers creating a wet season. Approximately 70 percent of the average annual rainfall occurs during this period. Weather patterns in the dry season (November to April) are influenced by cold continental air masses. Rains occur when these masses move over the Florida peninsula and meet warmer air. In contrast to localized, heavy thundershowers in the wet season, rains are light and tend to be uniform in distribution in the dry season (Ref. 10).

The main factors influencing climate at KSC are latitude and proximity to the Atlantic Ocean and the Indian and Banana Rivers, which moderate temperature fluctuations (Ref. 11). Results of the Cape Atmospheric Boundary Layer Experiment found that wind direction, especially the seabreeze front, is controlled by thermal differences between the Atlantic Ocean, Banana River, Indian River, and Cape Canaveral Land Mass. Heat is gained and lost more rapidly from land than water. During a 24-hour period, water may be warmer and again cooler than adjacent land. Cool air replaces rising warm air creating offshore (from land to ocean) breezes in the night and onshore (from ocean to land) breezes in the day. These sea breezes have been recorded at altitudes of 100 m (3,281 ft) and higher and reach further inland during the wet season. Seasonal wind directions are primarily influenced by continental temperature changes. In general, the fall winds occur predominantly from the east to northeast. Winter winds occur from the north to northwest shifting to the southeast in the spring and then to the south in the summer months (Ref. 10).

3.4.1 RAINFALL

Rainfall data are gathered from several collecting stations in the KSC area (Ref. 88). These stations (see Figure 3-1 for location) provide both long-term records (Merritt Island and Titusville) and site-specific data of special interest to KSC. Mean annual rainfall for Merritt Island and Titusville are 131 cm (51.6 in) and 136.6 cm (53.8 in), respectively. Annual rainfall varies widely; values for Merritt Island range from 77.4 cm (30.5 in) to 217.6 cm (85.7 in), and for Titusville range from 84.8 cm (33.4 in) to 207.5 cm (81.7 in). Distribution of rainfall is bimodal, with a wet season occurring from May to October, and the remainder of the year being relatively dry. There is noticeable variation in mean monthly rainfall amounts among the wet season months with little variation during the dry season (see Table 3-5 and Figure 3-6).

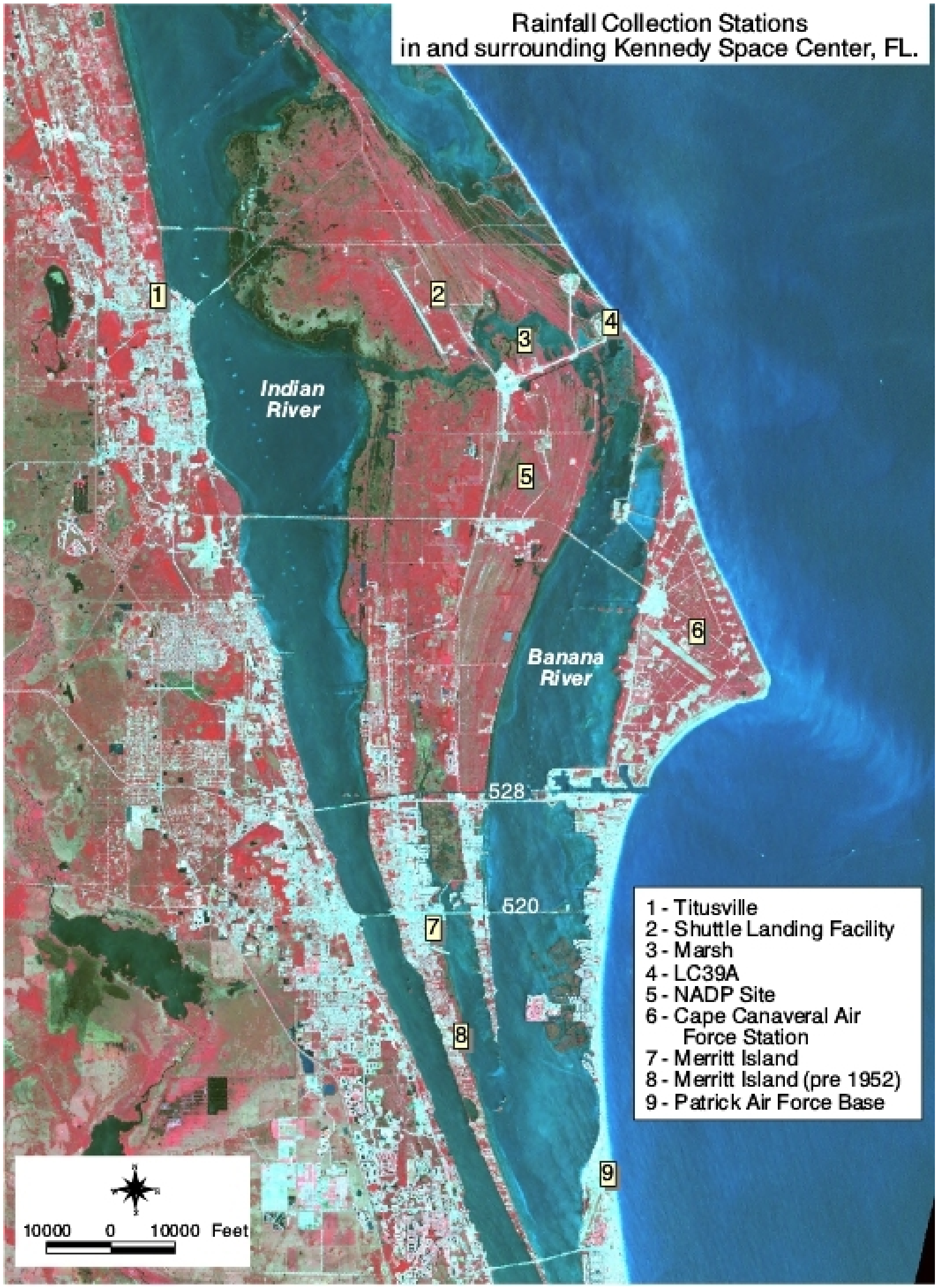

Figure 3-6. Rainfall Collection Stations In and Surrounding KSC.

Table 3-5. Monthly Mean Rainfall for KSC Area Collecting Stations.

Station	Titusville *	Merritt Island*	CCAFS *	NADP Site	LC-39A	Shuttle 1	Patrick *
Length of Records (yrs)	86	75	21	19	12	12	2
January	2.22	2.68	2.39	2.78	2.39	3.21	2.72
February	2.80	2.56	2.91	2.52	2.10	2.43	1.98
March	3.06	2.79	3.41	4.04	2.49	4.28	6.12
April	2.53	2.77	1.30	2.39	2.41	2.38	0.74
May	4.09	3.70	2.77	2.43	2.11	2.54	4.58
June	7.12	6.65	5.74	6.33	4.92	7.14	4.16
July	7.52	5.99	5.17	5.19	2.87	6.23	6.27
August	6.69	5.52	5.41	5.83	4.91	5.67	2.46
September	7.96	7.76	6.48	7.00	6.11	8.03	6.97
October	5.41	6.14	4.32	4.81	4.57	5.29	5.56
November	2.52	2.52	3.24	3.68	2.47	2.75	8.80
December	2.32	0.30	2.00	2.81	2.04	2.16	2.56
Total	54.24	51.38	45.14	49.81	39.39	52.12	52.92
Reference: *Source 11.							

On average, measurable precipitation occurs 148 days per year, with about 60 percent of these being in the wet season (Figure 3-7). Year-to-year variability in precipitation is high with drought conditions (high temperatures and low groundwater table) being somewhat common. The total annual precipitation for 2000 was only 91.44 cm (32.60 in), which is the lowest recorded in 19 years at the NADP site.

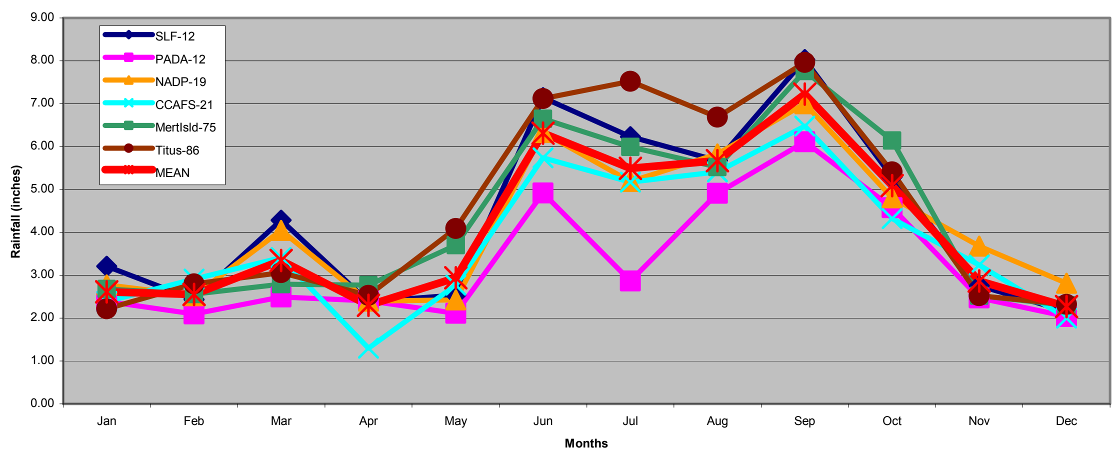

Figure 3-7. Monthly Rainfall at KSC Area Sites.

A comparison of the NADP rainfall for 2002 vs. the last 10-year mean shows the rainfall at the NADP site was drier than normal during the winter and spring and wetter than normal during the summer during 2002 (Figure 3-8).

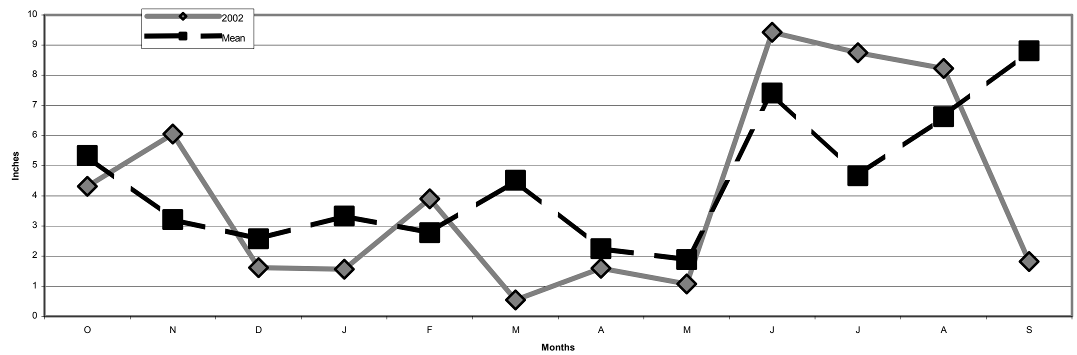

Figure 3-8. October 2001-September 2002 vs. 10-Year Mean for the NADP Rain Site.

There is a spatial component to rainfall at KSC and CCAFS as can be seen in a 10-year composite figure of data from the Tropical Rainfall Mesoscale Monitoring (TRMM) network (Figure 3-9). There is an east-to-west and north-to-south trend from drier-to-wetter sites across the domain. The wettest site on KSC is usually Site 18 or 22, while the drier sites are usually along the coastline, Sites 8, 24, 26, and 28. As previously mentioned, there is some degree of year-to-year variability.

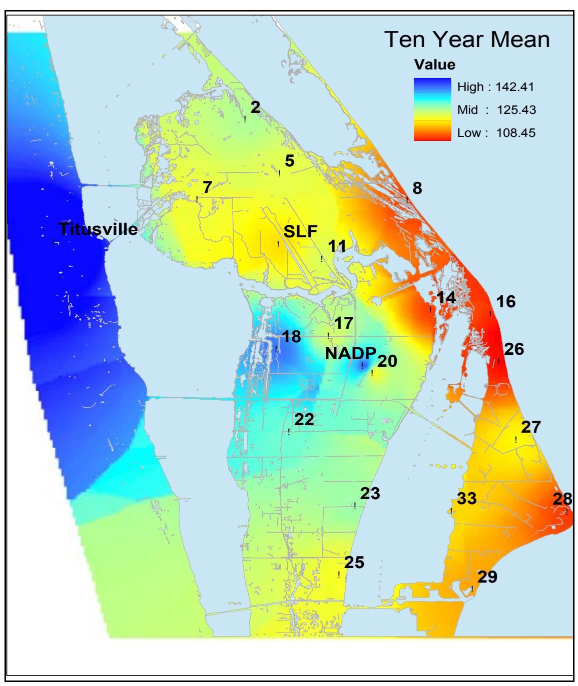

Figure 3-9. 10-Year Mean Rainfall at KSC.

3.4.2. TEMPERATURE

Monthly temperature variations for 2002 at PAMS A and the 18-year mean are shown in Figure 3-10. The warmest month of 2002 was September with an average temperature of 25.2 ^{o}C (77.4 ^{o}F), while July has the highest mean temperature of 26.8^{o}C (80.3^{o}F). January is the coldest month, on average, with a mean temperature of 13.9^{o}C (57^{o}F) for 2002, and an 18-year mean temperature of 15.8^{o}C (60.4^{o}F).

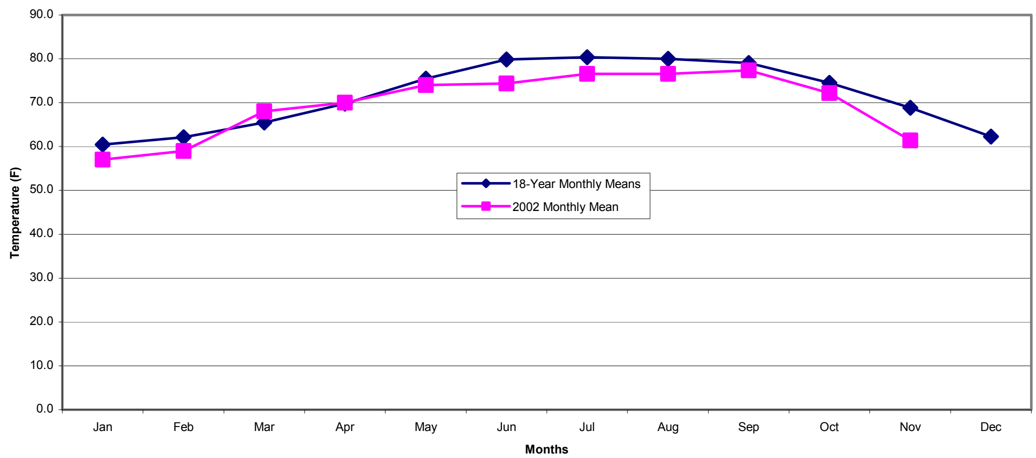

Figure 3-10. 2002 Monthly Mean Temperature vs. 18-Year Mean.

A plot of monthly minimum, mean, and maximum temperatures from 1984 through 2002 at PAMS A shows that there has been little change over this period (Figure 3-11).

Freezing temperatures in the KSC area have been analyzed for the Titusville and Merritt Island stations. Titusville has more recorded days of freezing temperatures than does Merritt Island and the freezing events are more severe. Cold air originates in the north or northwest and Merritt Island (including KSC) has the Indian River to moderate temperatures before cold air reaches the Island. For a 40-year period of concurrent records for Merritt Island and Titusville, Titusville shows 121 days with temperatures below freezing, while Merritt Island has only 30 such days. Titusville records lower temperatures than Merritt Island for the same freeze event, as well as, more frost occurrence. Over half of the Titusville freeze events lasted only one day with no record of maximum temperature during a freeze event being below freezing.

3.4.3 WIND

A summary of monthly prevailing wind data along with data on peak gusts is given in Table 3-6. Wind conditions over short-time periods are variable, depending on local convectional forces or land/sea breeze effects. Average monthly wind speeds range from 6 kts (July and August) to 9 kts (March). Monthly maximum recorded gusts for the period of record (1950-1952 and 1957-

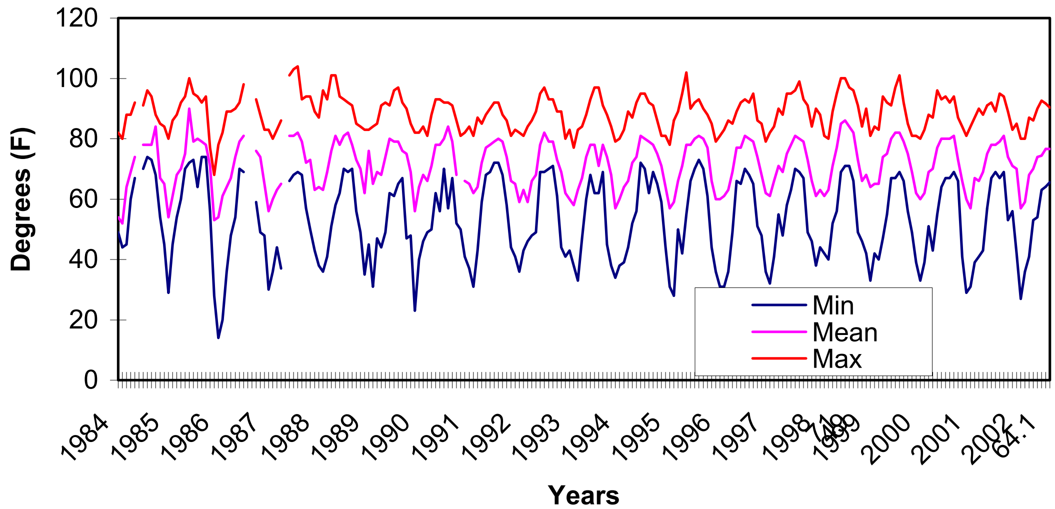

Figure 3-11. Ambient Temperatures (1984-2002).

1989) range from 40 kts to 68 kts. The highest wind speeds are encountered during tropical storms and hurricanes, which can produce sustained wind speeds over 87 kts. The prevailing wind direction is from the north or northeast during the dry season.

A series of seasonal wind roses are presented for wind direction data measured at the Shuttle Landing Facility from 1978 through 2000 (Figures 3-12 through 3-15). The primary wind direction in the winter is from the NW, in the spring from the N and SE, in the summer from the SE-S, and in the fall from the N and ENE-E.

An annual wind rose shows predominate winds for the entire year is from the N, E, and the SE-S (Figure 3-16). There are a three percent of calm winds for the entire year. The annual wind rose tends to 'smooth out' the seasonal patterns.

3.4.4 HUMIDITY

Humidity is high year-round with a seasonal fluctuation less than the diurnal fluctuation of 30 percent. Mean monthly relative humidity values for the CCAFS and the Shuttle Landing Facility range from 75 percent in April to 84 percent in August. Seasonally, humidity tends to be approximately 3 percent higher in the summer months. On a diurnal basis, humidity values range from 50-65 percent during afternoon hours to 85-95 percent during night and early morning hours. Mean monthly days with fog (visibility less than 11 km [7 mi]) ranges from 3 km (2 mi) in June-September to 14 km (9 mi) in January. Most fogs occur from November to March and are light, usually burning off by mid-morning. Figure 3-17 shows that the monthly mean humidity levels for 2002 were elevated for most of the year compared to the 18-year monthly means.

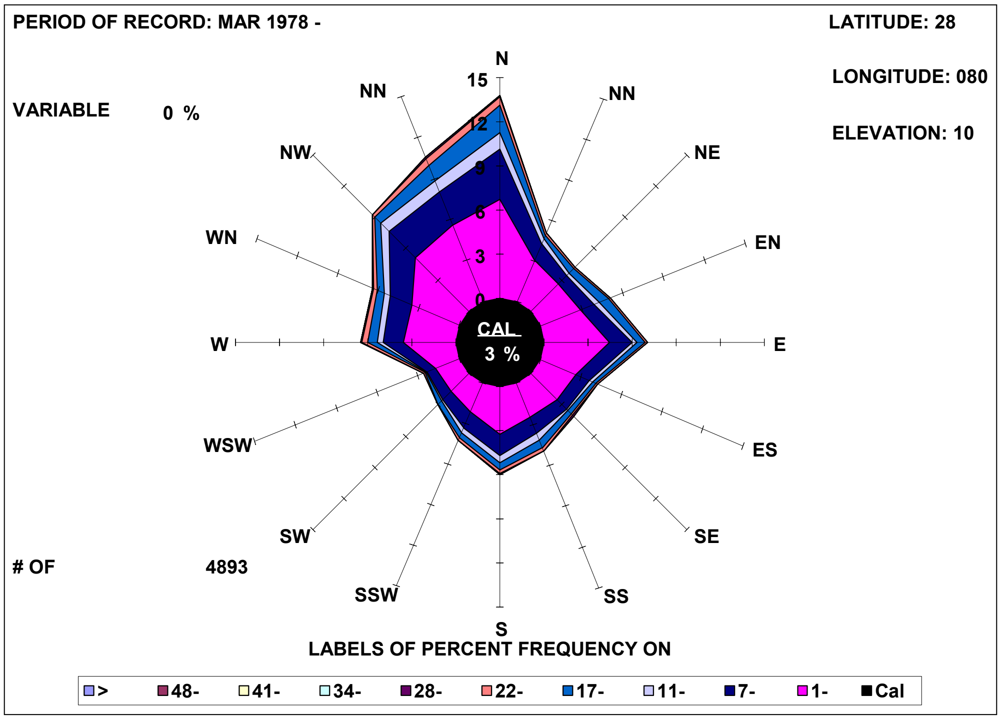

Figure 3-12. Seasonal Wind Rose (Winter).

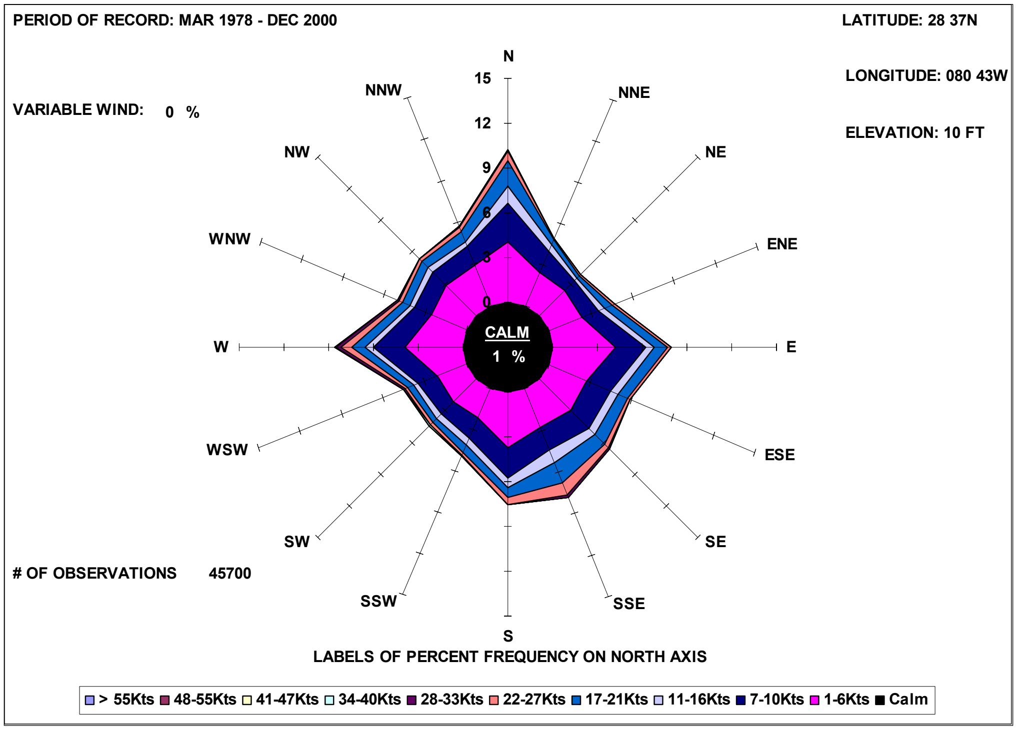

Figure 3-13. Seasonal Wind Rose (Spring).

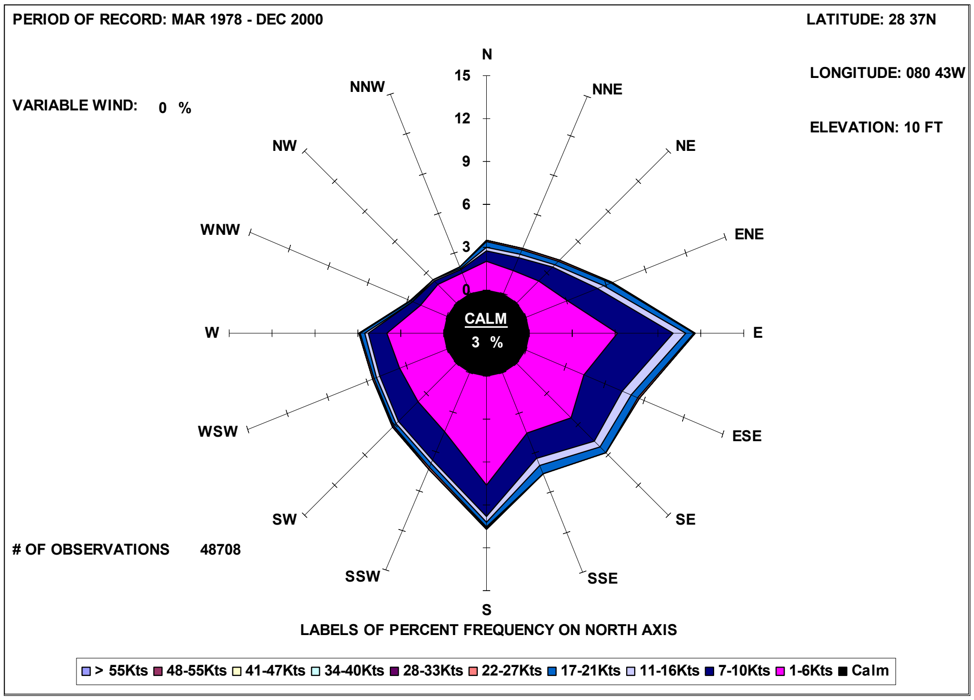

Figure 3-14. Seasonal Wind Rose (Summer).

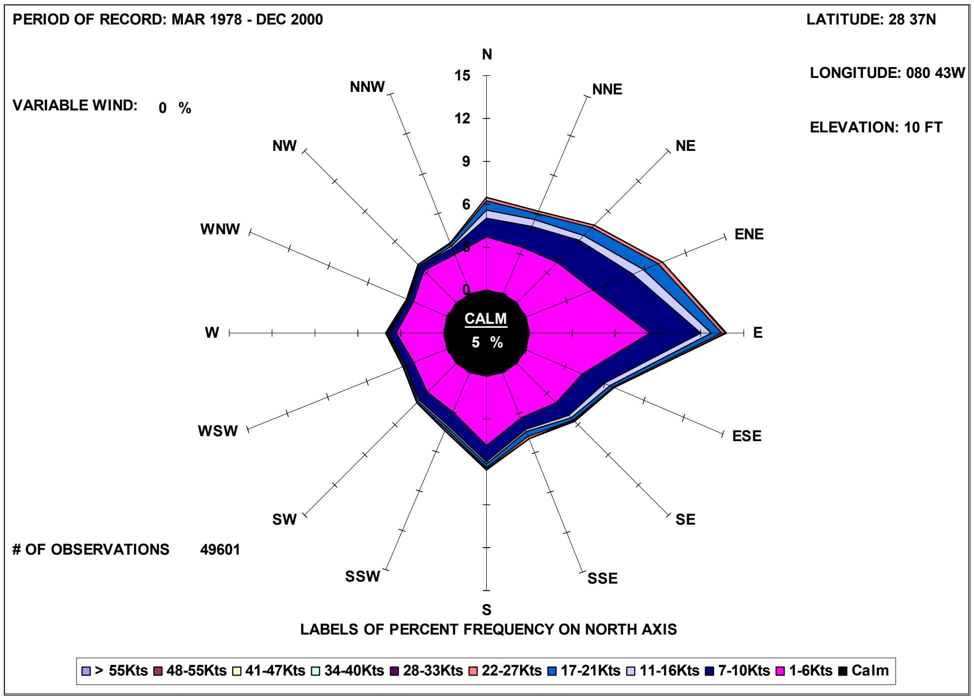

Figure 3-15. Seasonal Wind Rose (Fall).

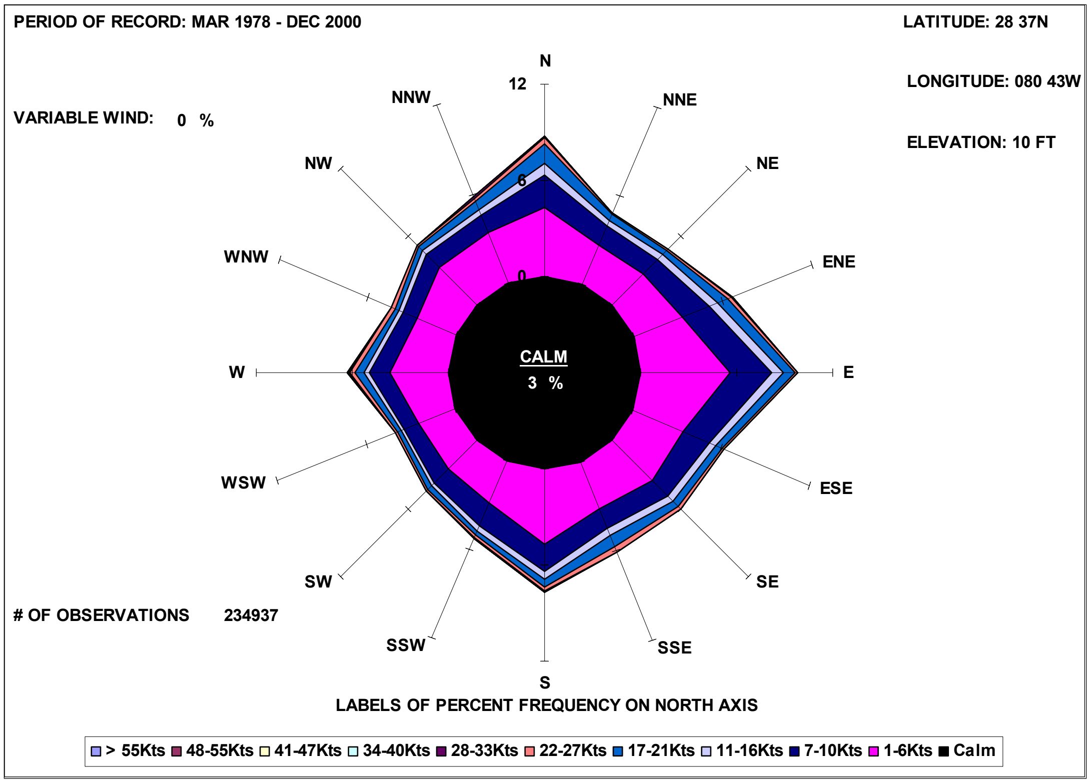

Figure 3-16. Annual Wind Rose.

Table 3-6. Wind and Humidity Values for KSC/CCAFS.

	Wind			Humidity
	Prevailing (Dir. + KTS)	**Peak Gust (KTS.)**	**Direction of Peak Gust**	**Mean Percent Relative Humidity**
January	NW8	46	270	80
February	N8	60	240	79
March	N9	48	180	77
April	E8a	53	200	75
May	E8	46	270	77
June	E7	50	160	81
July	S6	50	220	83
August	E6	60	-0-	84
September	E7	68	160	82
October	E8	40	30	78
November	NW8	46	190	78
December	NW7	40	310	79
Source: Ref. 11				

3.4.5 RADIATION

Incident solar radiation that is not reflected is either transmitted or absorbed. The absorbed radiation generally increases the temperature of the absorbing medium; this is then released to the environment as heat as the medium cools. Absorbed radiation can also cause a number of photic reactions with the materials it encounters; photosynthesis is an example of such a reaction in nature. Due to KSC's location in the "sun-belt" and the nature of the operations occurring there, solar radiation measurements are taken daily. Fourteen years of solar radiation data taken at the Florida Solar Energy Center (FSEC) at CCAFS are averaged by month and presented in Table 3-7.

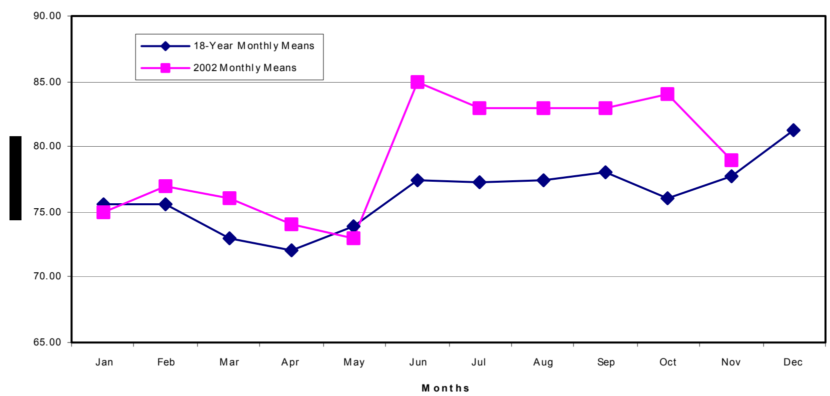

Figure 3-17. 2002 Monthly Mean Relative Humidity vs. 18-Year Means.

Table 3-7. Mean Daily Solar Radiation, January 1977 through December 1990.

	DIRECT NORMAL INSOLATION			TOTAL NORMAL NSOLATION			TOTAL INSOLATION ON A HORIZONTAL SURFACE			A TILTED SURFACE (INCIDENT ANGLE <5 DEG		
										AT SOLAR NOON)		
			BTU/SQ			BTU/SQ			BTU/SQ			BTU/SQ
	WATT	DAYS	FT	WATT	DAYS	FT	WATT	DAYS	FT	WATT	DAYS	FT
JAN	3960.2	375	1256.2	5691.0	133	1805.5	3285.9	331	1042.3	4833.0	392	1533.1
FEB	4144.9	367	1314.8	6675.1	118	2117.7	3964.8	371	1257.7	5071.6	367	1608.8
MAR	4760.0	389	1509.9	7290.2	135	2312.9	5237.8	392	1661.5	5738.6	394	1820.3
APR	5809.3	348	1842.8	8830.3	131	2801.5	6274.5	350	1990.3	6206.6	381	1968.8
MAY	5612.9	336	1780.5	8898.0	129	2823.0	6627.3	330	212.2	6396.8	358	2029.1
JUN	5209.3	330	1652.5	8430.5	128	2674.6	6439.0	329	2042.5	6282.4	331	1992.8
JUL	5357.6	330	1699.5	8514.6	133	2701.3	6377.9	341	2023.1	6308.7	332	2001.2
AUG	4892.9	372	1552.1	8048.5	137	2553.3	5954.9	372	1888.9	5915.9	372	1876.6
SEP	4288.2	361	1360.3	7225.3	133	2292.2	5168.9	368	1639.6	5469.3	365	1734.9
OCT	4097.2	355	1299.7	6552.9	142	2079.0	4431.5	351	1405.7	5382.2	358	1707.3
NOV	4139.3	350	1313.0	6249.3	138	1982.6	3496.4	332	1109.1	5095.0	350	1616.2
DEC	3541.9	366	1123.5	5381.9	136	1707.5	308.7	341	954.4	4691.2	374	1488.1
ANNUAL MEAN DAILY SOLAR RADIATION												
	4645.1	4279	1473.5	7315.6	1593	2320.9	5043.0	4208	1599.7	5600.0	4374	1776.4
Source: Ref. 12.												

3.4.6 EVAPORATION

An important part of the hydrological cycle is the return of some of the precipitation reaching the earth's surface to the atmosphere as vapor. The evaporation of water from water bodies and the transpiration of water vapor from plants are combined into one term and measured as evapotranspiration. The term potential evapotranspiration (PET) is defined as the evapotranspiration, that would occur were there is an adequate moisture supply at all times. Evapotranspiration is thus referred to as actual evapotranspiration (AET) in order to differentiate it from PET. The difference between precipitation and AET yields surplus. The AET values for CCAFS and Cocoa Beach are approximately 93 cm (37 in); and using an average annual precipitation of 140.7 cm (55.4 in), there is an annual surplus of roughly 45 cm (18 in) of water for the KSC area in an average year (Ref. 11). However, despite the overall surplus, two periods of moisture deficit occur in an average year: a two-month period between mid-March and mid-May and a one-month period between mid-November and mid-December (Ref. 11, Figure I-15).

3.4.7 WEATHER HAZARDS

3.4.7.1 Fog. The weather phenomena of the area of KSC is characterized by occasional fog. The fog, which results from the cooling of air, which remains at the earth's surface, usually appears in the early morning. Fog causes hazardous driving conditions particularly when combined with smoke from fires in woods or swamps (Ref. 9). Fog is defined as visibility less than 11 km (7 mi) and typically occurs two days in June through September and nine days in January. Most fogs occur from November to March and are light, usually burning off by mid-morning.

3.4.7.2 Temperature. Abrupt or extreme temperatures are not uncommon in the area and may effect operations at KSC, with the potential for heat exhaustion if working outdoors. While KSC's annual temperatures are moderated by its proximity to the Atlantic Ocean and Gulf Stream, recent winters have had longer cold periods. Although snow flurries have occurred in very light amounts at KSC, none were measurable. Sleet seldom occurs, but skim ice may form occasionally (Ref. 9).

3.4.7.3 Thunderstorms. Eighty percent of the storms at KSC occur in the months of May through September, with an average maximum of 16 thunderstorm days in July (Ref. 11). Thunderstorms most often occur from 2:00 to 6:00 p.m., with a peak occurrence at 4:00 p.m. The storm duration usually is brief; however, cloudbursts sometimes cause adverse driving conditions (Ref. 9). Regional thunderstorms range from a probability frequency of 2 percent low in January to a 50 percent high in July. Storms passing directly over KSC happen more commonly in the summer months with a relative frequency of approximately every nine days (Ref. 9).

3.4.7.4 Lightning. Data have been collected and analyzed for 79 summer storms that produced 10 or more electrical discharges (lightning) during the years 1976 through 1980. The analysis indicates that cloud and cloud-to-ground (CG) discharges occur at a mean rate of 2.4 discharges per minute per storm. The maximum flashing rate over a 5-minute interval was 30.6 discharges per minute on July 14, 1980 (Ref. 9). Estimates of the monthly area density of all discharges during the summers of 1974 through 1980, range from 2 to 10 discharges per square mile per month. The main area density of CG flashes alone is estimated to be 1 flash per square mile per month (Ref. 9).

3.4.7.5 Hail. Hailstorms are an infrequent occurrence at KSC; however, there is potential for significant damage and thus they may affect KSC's operations, if severe.

3.4.7.6 Tornadoes. Tornado statistics show a relatively high frequency for Florida with maximum activity in July, but the State ranks relatively low in tornado-related property damage and casualties. Tornadoes have occurred at KSC, buy they are rare and damage has been slight (Ref. 9).

3.4.7.7 Hurricanes. All of Florida is susceptible to hurricanes, but some parts of the state, namely southern Florida and the panhandle, experience more hurricanes than other parts. Hurricanes have wind speeds of 119 km/hr (74 mi/hr) or greater, while tropical storm winds are slower, ranging from 62 km to 117 km/hr (39 to 73 mi/hr). These storms often have rain areas as large as 560 km (300 mi) across and are relatively slow-moving so that a station could remain under the influence of an individual storm for three days or longer. Although tropical depressions and hurricanes occur throughout the wet season in Florida, only 26 hurricanes have passed within 100 nm of KSC and CCAFS since 1887 (Ref. 10). Hurricane Irene (1999) was the last hurricane to affect the KSC area. Figure 3-18 shows the occurrence of Hurricane landfalls in Brevard County, Florida, from 1900 through 2000. The most activity was in the 1920's through the 1940's (http://hurricane.csc.noaa.gov/hurricanes/index.htm (select Coastal Population)).

3.5 REFERENCES

1. Florida Department of Environmental Regulation. 1982. Exceedances of the Ambient Air Quality Standards in Florida: 1981. Bureau of Air Quality Management. Tallahassee, Florida.

2. Provancha, J.A. and Dreschel, T.W. 1986. Polygeneration Project Baseline Environmental Monitoring Program: Final Report. NASA/KSC Biomedical Office. John F. Kennedy Space Center, Florida.

3. Drese, J.H. 1985. Air Quality Summary and Monitoring Status at John F. Kennedy Space Center for the First Quarter (January-March) 1985. NASA/KSC Biomedical Office. Contract No. NAS 10-10285. John F. Kennedy Space Center, Florida.

4. Biomedial Support Contractor. 1990. Air Quality Summary and Monitoring Status at John F. Kennedy Space Center. For the First Quarter (January-March) 1990.

5. Biomedical Support Contractor. 1990. Air Quality Summary and Monitoring Status at John F. Kennedy Space Center. For the Second Quarter (April-June) 1990.

6. Biomedical Support Contractor. 1990. Air Quality Summary and Monitoring Status at John F. Kennedy Space Center. For the Third Quarter (July-September) 1990.

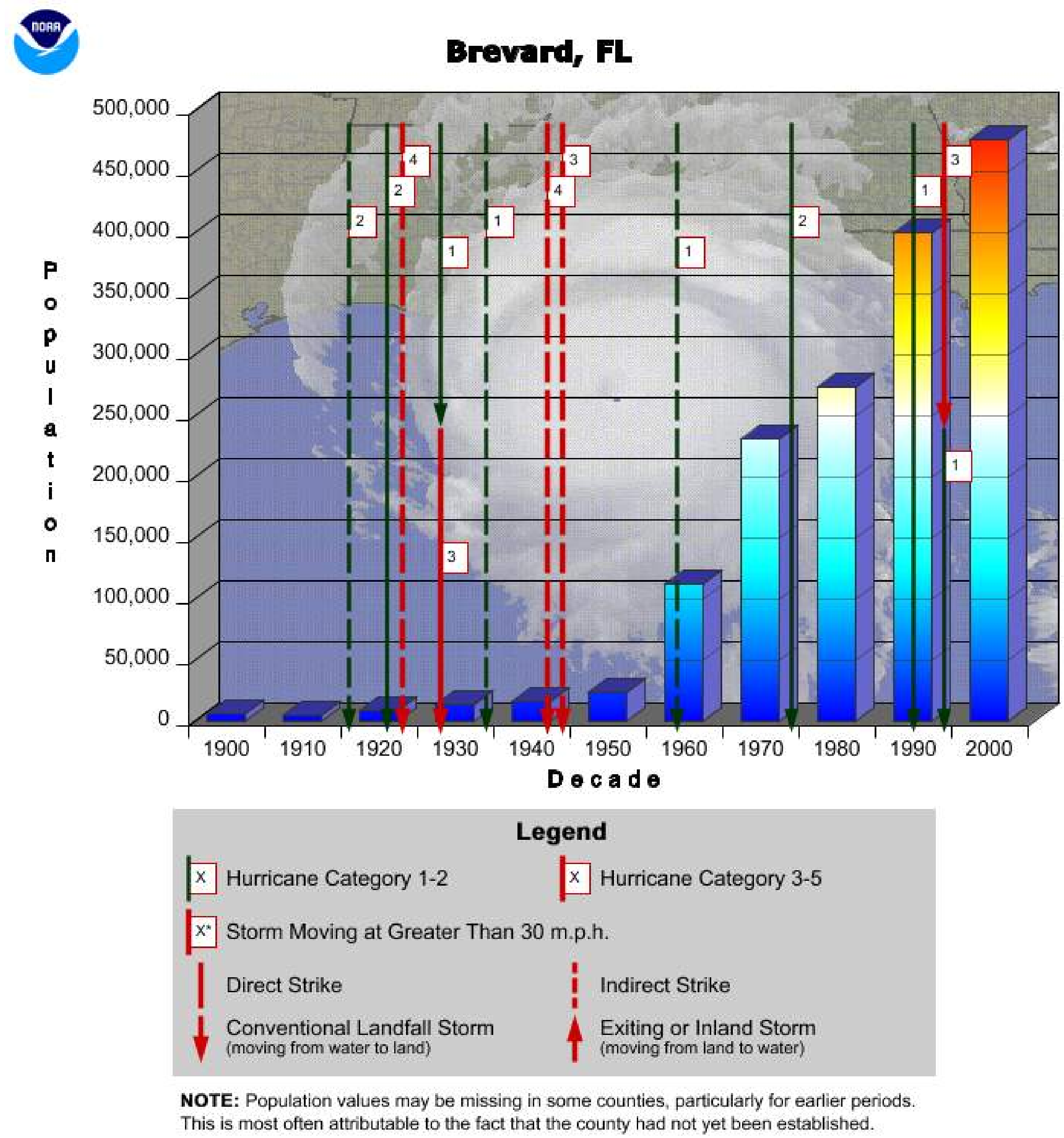

Figure 3-18. Occurrence of Hurricanes in Brevard County, Florida, from 1900 through 2000.

3.5 REFERENCES (continued)

7. Biomedical Support Contractor. 1990. Air Quality Summary and Monitoring Status at John F. Kennedy Space Center. For the Fourth Quarter (October-December) 1990.

8. Breininger, D.R., P.A. Schmalzer, and R.C. Hinkle. 1984. Comprehensive List of Endangered and Potentially Endangered Plants and Animals John F. Kennedy Space Center. NASA/KSC Biomedical Office, John F. Kennedy Space Center.

9. NASA. 1984. Master Plan. John F. Kennedy Space Center, Florida.

10. NASA. 1979. Final Environmental Impact Statement. John F. Kennedy Space Center, Florida.

11. Mailander, Joseph L. June, 1990. The Climate of the Kennedy Space Center and Vicinity. NASA Technical Memorandum No. 103498. Kennedy Space Center, Florida.

12. Florida Solar Energy Center. 1985. Mean Daily Solar Radiation: January 1977 Through December 1984. Technical Memorandum. Florida Solar Energy Center, Cape Canaveral, Florida.

SECTION IV

WATER RESOURCES

4.1 SURFACE WATERS

Kennedy Space Center is surrounded by the Indian River Lagoon (IRL) System and the Atlantic Ocean (Figure 4.1). The Indian River Lagoon System (IRLS) tem extends along the East Coast of Florida from Ponce de Leon Inlet to Jupiter. Lucie Inlet near Stuart, Florida. The IRLS consists of Mosquito Lagoon, Banana and Indian Rivers. Mosquito Lagoon and the Indian River are connected by Haulover Canal and the Intercoastal Waterway. Water flow between these two systems is primarily wind-driven. Because of the various man-made modifications related to the Space Program and mosquito control, circulation between Mosquito Lagoon and the Banana River was blocked in the earlier 1960s. The Indian and Banana Rivers mix in the region near Eau Gallie and through a man-made canal located just south of KSC. This system was formed by changing sea levels, and its prominent features are the southern barrier islands, the Cape Canaveral foreland formation, the western mainland ridges, and the valleys and sloughs between the ridges (Ref 1). These basins are shallow, aeolian, lagoons with depths averaging 1.8 m (5.9 ft) and maximums of 9 m (29 ft) generally restricted to dredged basins and channels.

The major fresh-water body within KSC property is Banana Creek, which drains the numerous estuaries adjacent to the Space Shuttle launch pads via a canal located northwest of the Vehicle Assembly Building to the Indian River. Salinity usually increases in a westward direction, but depending on wind direction, the Indian River system can have a greater or lesser affect on the Banana Creek water quality. Other freshwater inputs to the estuarine system surrounding KSC include direct precipitation, stormwater runoff, discharges from impoundments, and groundwater seepage (Ref. 2).

This area is very biologically diverse as it includes the temperate Carolinian and the subtropical Caribbean zoogeographic provinces. The lagoonal waters surrounding KSC are shallow flats that support dense growths of submerged aquatic vegetation including manatee grass (*Syringodium filiform\e*), shoal grass (*Halodule wrightii*), widgeon grass (*Ruppia maritima*), gulf halophila (*Halophila engelmannii*) and various macroalgae, such as *Gracilaria, Caulerpa, Sargassum, Laurencia, Penicillus, Acetabularia and Acanthophora*. Cool winter temperatures preclude the growth of turtle grass (*Thalassia testudinum*) in the KSC area (Ref. 3). Shorelines of the system near KSC are dominated by white mangrove (*Laguncularia racemosa*) and black mangrove (*Avicennia germinans*) with red mangrove (*Rhizophora mangle*) occurring in small patches; however, this region represents the northern limit of their range and the winter freezes of 1983, 1984, and 1989 significantly impact populations (Ref. 4). Fauna in the lagoon system near KSC represents both the Carolianian and Subtropical provinces. Most common species are; mullet (*Mugil cephalus*), spotted sea trout (*Cynoscion nebulosus*), red fish (*Sciaenops ocellatus*), sea catfish (*Arius felis*), and blue crabs (*Callinectes spp*). This unique environmental setting makes KSC one of the most diverse areas in the US (Ref. 3, 5, 6, 7, 8 and 9). Section 5 describes further information on biotic resources.

4.1.1 REGULATORY OVERVIEW

Surface waters at KSC include "Waters of the US," "Navigable Waters" and "Waters of the State" activities in which numerous Federal, State and regional regulations are subject to. EPA regulates the discharge of pollutants into navigable waters of the US under the Federal Clean Water (CWA) Act of 1977, as amended by the Water Quality Act of 1987. EPA adopted numerous regulations to implement the CWA found in Title 40 CFR. The Corps of Engineers (COE) administers dredge and fill activities in navigable waters through the authority of the Rivers and Harbors Act of 1899 (RHA) and in waters of the US (including isolated wetlands) through Section 404 of the CWA.

4.1.1.1 Water Quality Standards. The CWA requires each state to adopt water quality standards. These standards are established on the use and values of waters for public water supplies, propagation of fish and wildlife, recreation, agriculture, industry and navigation.

EPA was designated under the CWA as the Federal agency with regulatory jurisdiction over discharges of pollutants into the waters of the US. Their regulatory authority is vested in the National Pollution Discharge Elimination System (NPDES) Permit Program. NPDES permits are operating permits, which ensure compliance with State and Federal water quality standards.

State compliance with the CWA has been delegated to FDEP. Today, Florida surface waters are designated according to five classifications based on their potential use and value:

Class I	Potable Water Supplies
Class II	Shellfish Propagation and Harvesting
Class III	Recreation and Fish and Wildlife Propagation
Class IV	Agricultural Water Supplies
Class V	Navigation and Utility and Industrial Use

Minimum water quality standards for surface and ground waters have been established by FDEP (see Table 4-1). A complimentary water quality classification is provided by the designation of Outstanding Florida Waters (OFW). In OFW the ambient water quality establishes the primary water quality standard for regulatory purposes. Where ambient water quality is lower than designated surface water classification standards, then the higher standard is maintained. The site-specific nature of the OFW water quality standard is designed to ensure against any surface water degradation.

4.1.1.2 Water Use Permitting. A Consumption Use Permit is required by the St Johns River Water Management District (SJRWMD) for every consumption use of ground or surface water, which (1) exceeds more than 378,541 liters per day (100,000 gallons per day), average annual; (2) is from a facility (wells, pumps, etc.) or facilities, which is capable of withdrawing 3.7 million liters of water per day (1 million gallons of water per day) or more; or (3) is from a well in which the outside diameter of the largest permanent water bearing casing is 15 cm (6 in) or greater.

All permits will include certain limiting conditions set forth at Rule 40C-2.381. The District prohibits significant adverse impacts on offsite land uses and legal uses of water existing at the time of permit application.

Permitting authority is granted to SJRWMD under Section 373.216, F.S. by Rule 40C-2, F.A.C. In so doing, the State is attempting to conserve and promote the proper utilization of Florida's surface and ground waters. KSC is located in the District's Upper St. Johns River Administrative Basin.

4.1.1.3 Wetland Resource Management (Dredge and Fill) Permitting. The wetland resource regulatory authority granted to Federal and State agencies the discharge of pollutants to surface waters. The permitting of dredge and fill activities in Florida is subject to independent review and action by State and Federal regulatory agencies. Despite differing jurisdictional parameters between State and Federal agencies, a common joint form permit application has been developed. The joint form application notifies all regulatory authorities of a proposed action. Federal authority over dredge and fill operations is established by the CWA of 1977, the RHA of 1899, the NEPA, the U.S. Fish and Wildlife Coordination Act, the Safe Drinking Water Act, and the Endangered Species Act of 1973.

COE administers the Federal Dredge and Fill Permitting Program (referred to as wetlands resource permitting by FDEP) with assistance and review from other Federal agencies including the USFWS, the National Marine Fisheries Service (NMFS), and EPA.

COE exerts jurisdiction over all coastal and inland waters, lakes, tributaries to navigable waters, and adjacent wetlands. In addition, as a result of a ruling by EPA regarding interpretation of the "interstate commerce connection", COE has been authorized regulatory jurisdiction over all isolated wetlands and surface waters. Consequently, virtually any activity within wetlands or surface waters is subject to the COE permit authority.

FDEP administers the State wetland resource permit process (Chapter 62-312 F.A.C.). Under the provisions of The Warren S. Henderson Wetlands Protection Act of 1984, dredge and fill activities were largely consolidated under Chapter 403, F.S. FDEP jurisdiction extends over the "Waters of the State," which are defined to include, but not limited to, rivers, lakes, streams, springs, impoundments, and all other waters bodies, including fresh, brackish, saline, tidal, surface or underground. The Henderson Act clarifies FDEP jurisdiction over wetlands by establishing indicator wetland species and soil types. In addition, the Act establishes provisions for the special consideration of OFW in the permit application review process.

FDEP wetland resource permitting authority is supported by the Florida Game and Fresh Water Fish Commission (FGFWFC), which is responsible for the management, protection, and conservation of wild animal life and aquatic freshwater life, and the Florida Department of Environmental Protection-State Lands (formerly Florida Department of Natural Resources), which processes requests for the use of State-owned lands, including submerged bottoms.

Effective October 1, 1988, SJRWMD delegates wetland resource permitting within the District. SJRWMD reviews all wetland resource permit applications, whenever an activity requires a stormwater discharge permit with the following exceptions:

- All wetland resource permits for solid, industrial, domestic, and hazardous waste treatment facilities will be reviewed by FDEP
- District projects will be permitted by FDEP
- Power plant siting will be processed by FDEP
- Corps of Engineers water resources projects will be permitting by FDEP
- Marinas (10 or more boat slips)
- Other activities listed in the delegation agreement

4.1.1.4 Stormwater Runoff. Stormwater runoff control and management programs have become increasingly important in recent years and will continue to grow in importance to KSC. The Water Quality Control Act of 1987 requires EPA to permit industrial and municipal stormwater discharges. On November 16, 1990, EPA issued the final rule for the NPDES permit application regulations for stormwater discharges (40 CFR Parts 122, 123, and 124). Applications for stormwater discharges associated with industrial activity were required by March 18, 1991, for a permit through a group application or by November 18, 1991, for an individual permit. In addition, NPDES stormwater permits are required for all construction projects that impact an area equal to, or greater than, 2 ha (5 ac).

FDEP has stormwater permit authority for discharges to surface water as defined in Chapter 40C- F.A.C. (as administered by SJRWMD) and groundwater as defined in 62-4 F.A.C. The stormwater rule is designed to minimize permit requirements for stormwater designs, which utilize best management practices. FDEP has been authorized to delegate stormwater permitting authority to the State water management Districts or local Governments and several Districts have assumed this regulatory function including SJRWMD.

4.1.1.5 Surface Water Management. The Florida Water Resource Act, (Chapter 373 FS) enacted in 1972, created 6 water management Districts. The Districts were assigned to the major watersheds within the State and were provided with the authority to manage and regulate surface waters. Regulated activities include any construction, alteration, maintenance, or operation of any dam, impoundment, reservoir or works, including ditches, canals, conduits, channels, culverts, pipes, and other construction that connects to, draws water from, drains water into, or is placed in or across open waters or wetlands. Each District establishes thresholds, which trigger permit application requirements.

KSC is located within the watershed area administered by SJRWMD. SJRWMD has a Comprehensive Surface Water Management Permitting Program in place.

4.1.1.6 Outstanding Florida Waters. A special classification has been established for certain water bodies, which possess demonstrated exceptional recreational or ecological significance. OFW, include waters within National and State parks, wildlife refuges, aquatic preserves, and other State and Federal areas. Areas designated as OFW are afforded the highest protection of any surface waters in the State of Florida. Water quality standards for OFW are established by the ambient water quality. Where ambient water quality is lower then the higher standard becomes applicable. FDEP is the principle State agency responsible for the administration of OFW.

4.1.1.7 Aquatic Preserves. The Aquatic Preserve Act of 1975 (Chapter 258 F.S.) sets aside certain State-owned submerged lands and associated coastal waters in areas, which have exceptional biological, aesthetic, and scientific values. The aquatic preserve designation substantially restricts or prohibits activities requiring dredge and fill permits, drilling or gas or oil wells, and the discharge of wastes or effluents. FDEP is the State agency responsible for the administration of the Aquatic Preserve Program. As the administering agency, FDEP is required to develop and implement management plans for the preservation, protection, and enhancement of the natural resources of each aquatic preserve. There are no aquatic preserves designated for KSC lands or waters. See Table 4-1 and Figures 4.1 and 4.2.

Table 4-1. Surface Water Segments Physical Characteristics.

Surface Water Segment	Area (Acres)	Drainage Area (Acres)	Average Depth (Feet)
Indian River	10,091	46,409	<6
Banana River	18,096	33,950	<6
Mosquito Lagoon	25,121	25,378	<6
Total	53,308	105,737	

4.1.1.8 Oceanic and Tidal Influence. The Ponce de Leon Inlet is an oceanic connection to Mosquito Lagoon located approximately 49 km (31 mi) north of KSC. Port Canaveral provides an oceanic connection to the Banana River approximately 12 km (7.5 mi) south of KSC. Navigation locks within Port Canaveral virtually eliminate any significant oceanic influence on the Banana River. The Sebastian Inlet, located 80 km (50 mi) south of KSC, is the next southerly oceanic connection to the Indian River. The remoteness of the estuarine waters, from oceanic influence and the restrictions imposed by constructed causeways, minimize water circulation within the lagoon basins. Surface water movement and flushing are primarily functions of wind driven forces and salinity regimes are mostly controlled by precipitation, upland runoff, evaporation, and groundwater seepage. Much information on water resources of the Indian River Lagoon have been compiled under the SWIM Plan (Ref. 3) and a bibliography has been published by the Marine Resources Council of East Central Florida (Ref. 10).

4.1.1.9 Navigation. Navigable channels including the Intracoastal and the Turning Basin access channel are excavated waterways. The Intracoastal Waterway follows the Indian River through Haulover Canal and proceeds north through Mosquito Lagoon. Dredged material from the construction of the Intracoastal Waterway and the Turning Basin access channel was typically deposited along the waterways as small islands. The Intracoastal Waterway has a variable width and a design depth of 3 m (12 ft).

The Turning Basin access channel extends from Port Canaveral north through the Banana River to the VAB area. A channel spur to Hangar AF provides navigable access for two vessels used

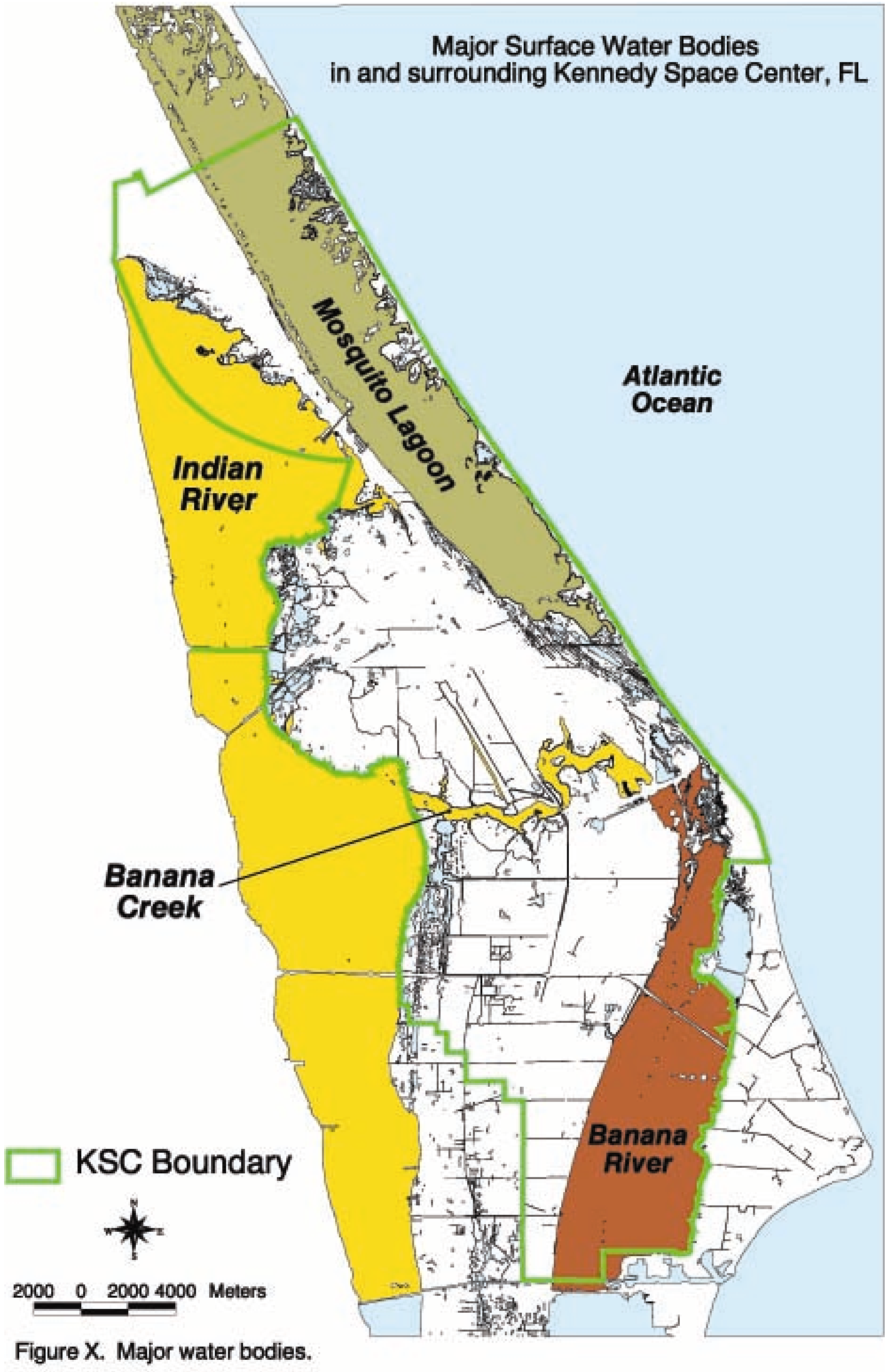

Figure 4-1. Major Water Bodies Around KSC.

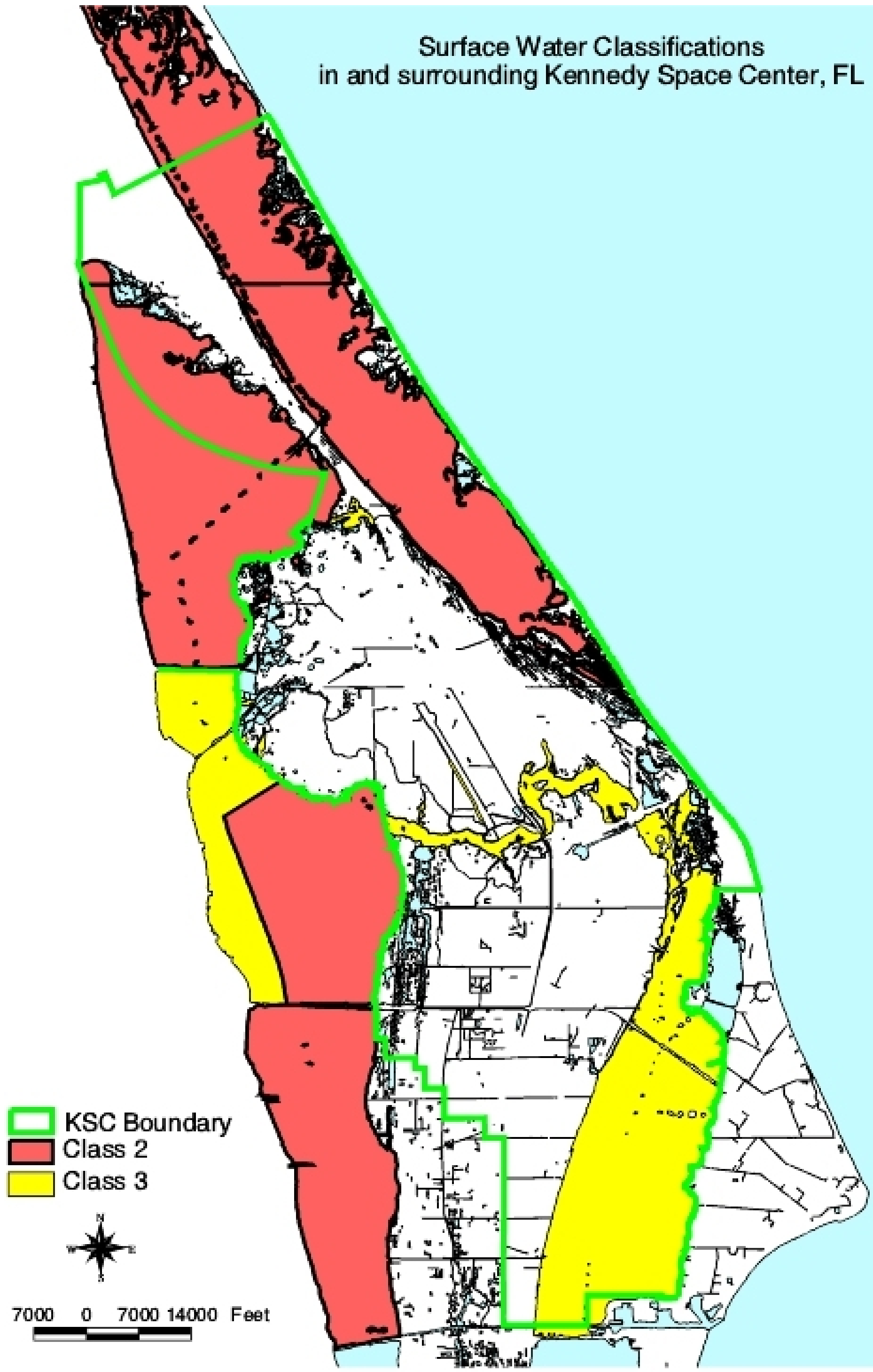

Figure 4-2. Classification of Water Bodies Around KSC.

in the retrieval of SRBs. Public navigational access is prohibited north of the NASA Parkway East.

The Banana River, from KARS Park north, has been closed to powered vessels with the designation of the area as a Manatee sanctuary (see Section 5.2.5).

4.1.2 KSC SURFACE WATERS CLASSIFICATION

In compliance with the CWA, the State has classified water surrounding the Kennedy Space Center.

4.1.2.1 Class II. All of the area of Mosquito Lagoon within KSC boundaries and the northern-most segment of the Indian River extending from the NASA Railway spur crossing are designated as Class II - Shellfish Propagation or Harvesting (see Figure 4-2). Class II waters establish more stringent limitations on bacteriological and fluoride pollution and the discharge of treated wastewater effluent are prohibited. Dredge and fill projects in Class II waters require a plan of procedure to adequately protect the project area from significant damage.

4.1.2.2. Class III. The remainder of surface waters surrounding KSC is designated as Class III - Recreation-Propagation and Management of Fire and Wildlife. Class III water standards (reference Table 4-1) are intended to maintain water quality suitable for body contact sports and recreation and the production of diverse fish and wildlife communities.

4.1.2.3 KSC Outstanding Florida Waters. The surface waters within the MINWR have been designated as OFW (see Figure 2-2). The OFW designation supersedes other surface water classifications and water quality standards are based on ambient water quality below the existing levels; that is, these waters cannot be degraded below their ambient standards even if they are cleaner than the standards for that classification.

4.1.2.4 Aquatic Preserves. The entire Mosquito Lagoon has been designated by the Board of Trustees of the Internal Improvement Trust Fund as an Aquatic Preserve. The Mosquito Lagoon Aquatic Preserve Management Plan has been published (Ref. 11), but it has no jurisdiction in Federal waters based on agreements with the State that turn their management over to the Federal agencies.

The Banana River aquatic preserve begins at SR 528 (Bennett Causeway) and extends south to Mathers Bridge and includes that entire section of the Banana River and portions of Sykes Creek and Newfound Harbor. A Management Plan has been developed for this aquatic preserve (Ref. 12). The Banana River aquatic preserve does not extend to KSC and NASA operations and are not affected by the implementation of the Management Plan.

4.2 KSC SURFACE WATER QUALITY MONITORING PROGRAMS

4.2.1 LONG-TERM PROGRAMS

Surface water quality at KSC is considered to be generally good. The best areas of water quality are adjacent to undeveloped areas of the lagoon, such as North Banana River, Mosquito Lagoon, and the northernmost portion of the Indian River (Ref. 13). In order to document the surface water quality of waters surrounding KSC, several different monitoring programs are used. NASA, SJRWMD, and Brevard County maintain water quality monitoring stations around-and-within KSC boundaries. The SJRWMD lagoon-wide network maintains two surface water quality-monitoring stations within KSC (Figure 4-3). Surface water quality data is collected by KSC and is submitted to SJRWMD for incorporation into a region-wide data management system. The surface water quality data from this program is used for long-term trend analysis and offers a supportive role in land use planning for the entire Indian River Lagoon. NASA also supports a network of surface water quality monitoring sites as a function of its long-term Water Quality Monitoring Program. Eleven sites are sampled on a quarterly basis for physical and chemical parameters, including nutrients and metals (Figure 4-3). Most of the monitoring sites are located away from major facilities and operational areas as background stations to characterize ambient conditions, which can be compared to several sites, that are located near launch complexes to monitor any short-term or long-term impacts.

4.2.2 1998 BACKGROUND CENTERWIDE MONITORING

In 1998, a comprehensive study to document background chemical composition of soils, groundwater, surface water, and sediments of John F. Kennedy Space Center was conducted. In addition to the on going, long-term surface water quality monitoring sites 40 additional locations were examined. Location of the surface water sampling stations was determined based on the watershed basins. Forty stations were selected to incorporate samples from open lagoonal water, rivers, creeks, ditches, borrow pits, and impoundments. Samples were collected using standard sampling protocols. Basins included Banana Creek, Banana River, Indian River Lagoon, Mosquito Lagoon, saline ditches (salinity > 6 ppt), and freshwater ditches (salinity < 6 ppt) (see Figure 4-3) (Ref. 2).

Surface water was analyzed for organochlorine pesticides, aroclors, chlorinated herbicides, PAH, and metals. Field parameters such as pH, temperature, turbidity, dissolved oxygen (DO), and conductivity were also measured at each sampling location.

Six aroclors (6) and 18 chlorinated herbicides were below detection. One of 25 organochlorine pesticides (Dieldrin) was above detection as were five of 17 PAHs. Sixteen of 24 metals were above detection limits; eight (Ba, Cd, Cr, Co, Hg, Ni, Vn, and Zn) were always below detection. Two PAHs (naphthalene, fluorene) and one metal (Cu) were above detection in only one sample. The Remediation Team treated those below detection. The occurrence of Dieldrin is probably related to past agricultural use. Concentrations of PAHs were low; these may result from natural sources or regional deposition.

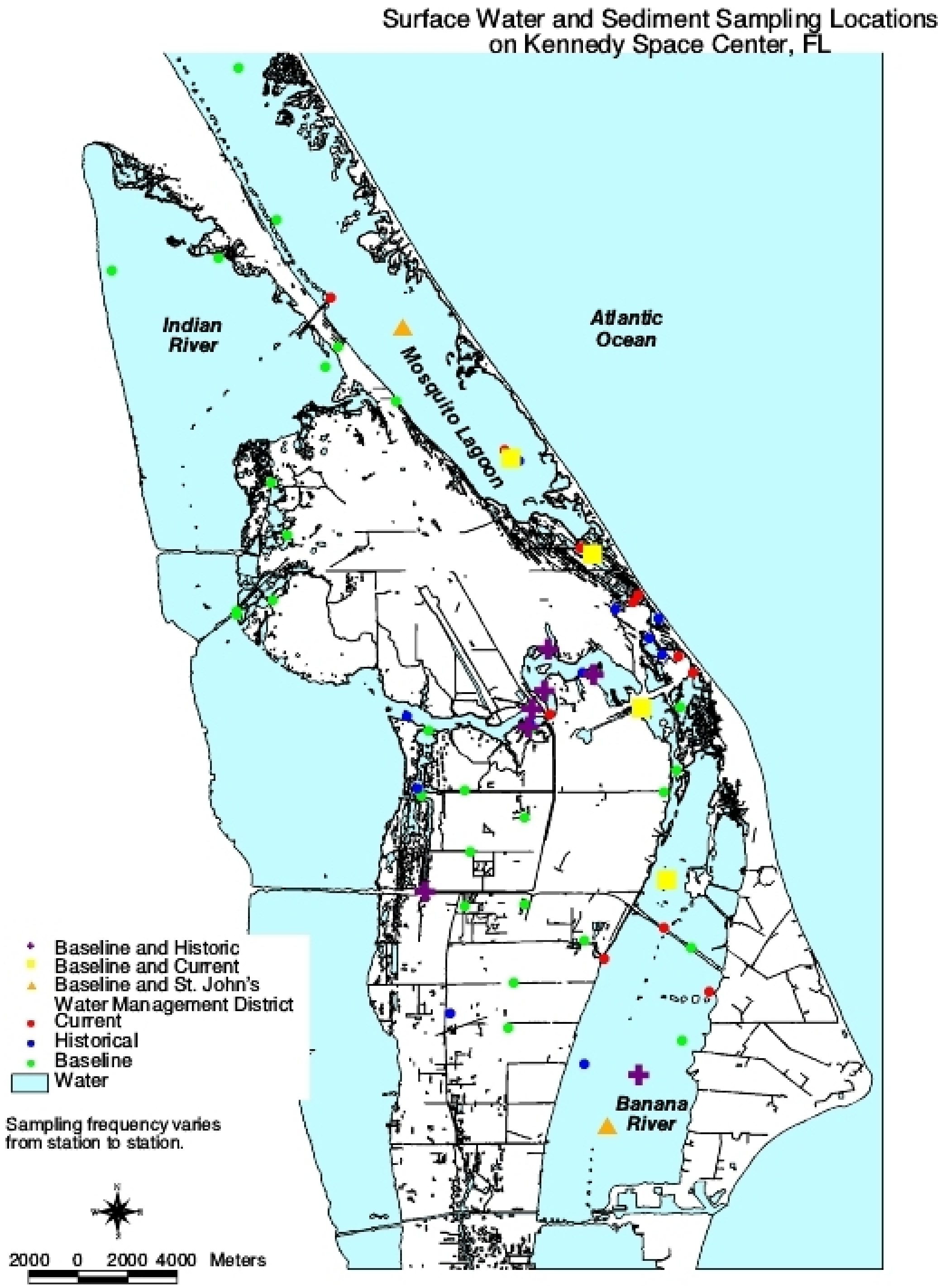

Figure 4-3. Water Quality and Sediment Sampling Stations on KSC.

Nine metals (Sb, As, Be, Cu, Pb, Mn, Se, Ag, and Tl) were above detection in too few samples to test for differences among watershed basins. Seven metals commonly above detection limits (Al, Ca, Cl, Mg, Fe, K, and Na) differed among basins (ANOVA, $p<0.05$). Patterns of differences varied among metals. For Al, Banana Creek was higher than the other basins. Fe was higher in Banana Creek, saline ditches, and freshwater ditches compared to Banana River, Indian River Lagoon, and Mosquito Lagoon. Highest values of Ca, Cl^-, and Mg occurred in three classes with Banana Creek, Mosquito Lagoon, and Indian River Lagoon; intermediate values in Banana River and saline ditches; low values in freshwater ditches. K was highest in Mosquito Lagoon, intermediate in Banana Creek, Indian River Lagoon, Banana River, and saline ditches, and lowest in freshwater ditches. Na was highest in Mosquito Lagoon and the Indian River Lagoon, intermediate in Banana Creek, Banana River, and saline ditches, and lowest in freshwater ditches (Ref. 2).

Table 4-2 list parameters, EPA methods, and detection limits used to analyze surface water samples collected for the 1998 KSC Background Study.

Table 4-2. Surface Water Containment Levels.

	EPA Method	**Lab Reporting Limit for Surface Water**
Organochlorine Pesticides		
4,4' – DDD	8081	0.05 µg/L
4,4' – DDE	8081	0.05 µg/L
4,4' – DDT	8081	0.05 µg/L
Aldrin	8081	0.05 µg/L
Alpha – BHC	8081	0.05 µg/L
Beta – BHC	8081	0.05 µg/L
Chlordane (alpha)	8081	0.05 µg/L
Chlordane (Gamma)	8081	0.05 µg/L
Chlordane (Total)	8081	0.05 µg/L
Delta – BHC	8081	0.05 µg/L
Dieldrin	8081	0.05 µg/L
Endosulfan I	8081	0.05 µg/L
Endosulfan II (Beta)	8081	0.05 µg/L
Endosulfan Sulfate	8081	0.05 µg/L
Endrin	8081	0.05 µg/L
Endrin Aldenhyde	8081	0.05 µg/L
Endrin Ketone	8081	0.05 µg/L
Gamma – BHC (Lindane)	8081	0.05 µg/L
Heptachlor	8081	0.05 µg/L
Heptachlor Epoxide (a)	8081	0.05 µg/L
Heptachlor Expoxide (b)	8081	0.05 µg/L
Isodrin	8081	0.05 µg/L
Methoxychlor	8081	0.05 µg/L
Mirex	8081	0.05 µg/L
Toxaphene	8081	2 µg/L

Table 4-2. Surface Water Containment Levels (continued).

	EPA Method	Lab Reporting Limit for Surface Water
Aroclors		
PCB – 1016/1242	8082	1 µg/L
PCB – 1221	8082	1 µg/L
PCB – 1232	8082	1 µg/L
PCB – 1248	8082	1 µg/L
PCB – 1254	8082	1 µg/L
PCB – 1260	8082	1 µg/L
Chlorinated Herbicides		
2 – (2, 4, 5 – Trichlorophenoxy) propionic acid (2, 4, 5 – TP) (Silvex)	8151	0.5 µg/L
2, 4, 5 – Trichlorophenoxy acetic acid (2, 4, 5 – T)	8151	0.5 µg/L
2, 4 – Dichlorophenoxy acetic acid (2, 4 – D)	8151	0.5 µg/L
3, 5 – DCBA	8151	0.5 µg/L
4 (2, 4 – Dichlorophenoxy) butyric acid (2, 4 – DB)	8151	0.5 µg/L
Chlorinated Herbicides (continued)		
4 – Nitrophenol	8151	0.5 µg/L
Acifluorfen	8151	0.5 µg/L
Bentazon	8151	0.5 µg/L
Chloramben	8151	0.5 µg/L
Dacthal	8151	0.5 µg/L
Dalapon	8151	0.5 µg/L
Dicamba	8151	0.5 µg/L
Dichloroprop [2 – (2, 4 – Dichlorophenoxy) proponic acid]	8151	0.5 µg/L
Dinoseb	8151	0.5 µg/L
MCPA		
MCPP	8151	5 µg/L
Pentachlorophenol	8151	0.5 µg/L
Picloram	8151	0.5 µg/L
Polyaromatic Hydrocarbons		
1 – Methylnaphthalene	8310	0.5 µg/L
2 – Methylnaphthalene	8310	0.5 µg/L
Acenaphthene	8310	0.5 µg/L
Acenaphthylene	8310	0.1 µg/L
Anthracene	8310	0.5 µg/L
Benzo (a) anthracene	8310	0.5 µg/L
Benzo (a) pyrene	8310	0.5 µg/L
Benzo (b) fluoranthene	8310	0.1 µg/L
Benzo (g, h, I) perylene	8310	0.1 µg/L
Benzo (k) fluoranthene	8310	0.05 µg/L
Chrysene	8310	0.05 µg/L
Dibenzo (a, h) anthracene	8310	0.1 µg/L
Fluoranthene	8310	0.1 µg/L
Fluorene	8310	0.1 µg/L
Indeno (1, 2, 3 – cd) pyrene	8310	0.05 µg/L
Naphthalene	8310	0.5 µg/L

Table 4-2. Surface Water Containment Levels (continued).

	EPA Method	Lab Reporting Limit for Surface Water
Polyaromatic Hydrocarbons (continued)		
Phenanthrene	8310	0.05 µg/L
Pyrene	8310	0.05 µg/L
Metals		
Aluminum	200.7	0.05 mg/L
Antimony	200.7/ 204.2	0.006 mg/L
Arsenic (as carcinogen	200.7	0.01 mg/L
Barium	200.7	0.01 mg/L
Beryllium	200.7	0.001 mg/L
Cadmium	200.7	0.001 mg/L
Calcium	200.7	0.5 mg/L
Chloride, Total	325.3	1 mg/L
Chromium (Total)	200.7	0.01 mg/L
Cobalt	200.7	0.05 mg/L
Cooper	200.7/ 7211	0.05 mg/L
Iron	200.7	0.05 mg/L
Lead	200.7	0.005 mg/L
Magnesium	200.7	0.5 mg/L
Manganese	200.7	0.01 mg/l
Mercury (inorganic)	7470	0.0002 mg/L
Nickel	200.7	0.01 mg/L
Potassium	200.7/ 258.1	0.5 mg/L
Selenium	200.7	0.01 mg/L
Silver	200.7/ 7761	0.01 mg/L
Sodium	7770	0.5 mg/L
Thallium	279.2	0.004 mg/L
Vanadium	200.7	0.01 mg/L
Zinc	200.7	0.1 mg/L
Other Parameters		
Dissolved Oxygen	*	**N/A**
PH	*	N/A
Specific Conductivity	*	N/A
Temperature	*	N/A
Total Dissolved Solids	160.1	N/A
Total Organic Carbon	415.1	1 mg/L
Turbidity	180.1	N/A
(Note: * = measurement made with a calibrated field instrument (YSI) (Ref. 2).		

4.3 REFERENCES

1. Head, C.M. 1981. Geological Perspective of Florida. Unpublished Report.

2. Schmalzer, P. A., M. A. Hensley, M. Mota, C.R. Hall, and C. A. Dunlevy. 2000. Soil, Groundwater, Surface Water, and Sediments of Kennedy Space Center, Florida: Background Chemical and Physical Characteristics. NASA Technical Memorandum 2000-20853. 595 pp.

3. St. Johns River Water Management District, South Florida Water Management District. 1989. Surface Water Improvement and Management (SWIM) Plan for the Indian River Lagoon. 100 pp.

4. Provancha, M.J. P.A. Schmalzer, C.R. Hall. 1986. Effects of the December 1983 and January 1985 Freezing Air Temperatures on Aquatic Poikilotherms and Plant Species of Merritt Island, Florida. Florida Scientist. Chapter 49, pp. 199-212.

5. Florida Institute of Technology. 1975. Ecological Study of Lagoons Around John F. Kennedy Space Center: A Final Report to John F. Kennedy Space Center, National Aeronautics and Space Administration. John F. Kennedy Space Center, Florida.

6. Gilmore, R.G. 1977. Fishes of the Indian River Lagoon and Adjacent Waters, Florida. Bull. Florida St. Mus., Biol. Sci. 22:101-148.

7. Gilmore, R.G., P.A. Hastings and D.J. Herrema. 1983. Ichthyofaunal Additions to the Indian River Lagoon and Adjacent Waters, East-Central Florida. Florida Sci. 46:22-30.

8. Goggin, John M. 1952. Space and Time Perspectives in Northern St. Johns Archaeology, Florida. Yale University Publications in Anthropology 47.

9. Snelson, F.F., Jr. 1983. Ichthyfauna of the Northern Part of the Indian River Lagoon System, Florida. Florida Sco. 46:187-206.

10. Steward, J.S. and J.A. Van Arman. 1987. Indian River Lagoon Joint Reconnaissance Report. St. Johns River Water Management District and South Florida Water Management District.

11. Black, B.B., M.W. Collipy, H.F. Percival, A.A. Tiller, and PG.G. Bohall. 1984. Effects of Low Level Military Training Flights on Wading Bird Colonies in Florida. Florida Coop. Fish and Wildlife Res. Unit, Sch. For. Res. And Sonserv., Univ. of Florida. Tech. Report. No. 7.

12. Florida Department of Natural Resources. 1985. Banana River Aquatic Preserve Management Plan. Tallahassee, Florida.

13. Brevard County, 1990. The 1988 Brevard County Comprehensive Plan, Brevard County, Florida.

SECTION V

LAND RESOURCES

5.1 SOILS

Soils differ through the interaction of several factors: climate, parent material, topography, organisms, and time (Ref. 1 and 2). The soils of KSC are mapped in the soil surveys for Brevard County (Ref. 3) and Volusia County (Ref. 4), and the resulting soil pattern is complex. Numerous soil series and land types are represented even though Merritt Island is a relatively young landscape and one formed from coastal plain deposits. Some differences in soil parent material do occur. In particular, soils that formed in deposits over limestone, coquina, or other alkaline material differ greatly in properties from those formed in sand. Textural differences in parent material, such as that between loam or clay material and sand, also influence soil properties.

The primary source of parent material for KSC soils is sands of mixed terrestrial and biogenic origin. The terrestrial material originated from southern rivers carrying sediments eroded from highly weathered Coastal Plain and Piedmont soils; these sediments are quartzose with low feldspar content (Ref. 5). These sediments moved south through long-shore transport and may have been reworked repeatedly. The biogenic carbonate fraction of the sand is primarily of mollusk or barnacle origin with lesser contributions of coralline algae and lithoclasts; some may be reworked from offshore deposits of coquina and oolitic limestone (Ref 5).

The Cape Canaveral-Merritt Island complex is not all of the same age. Soils on Cape Canaveral, False Cape, and the barrier island section on the east side of Mosquito Lagoon are younger than those of Merritt Island and, therefore, have had less time to weather. Well-drained soil series (e.g., Palm Beach and Canaveral) in these areas still retain shell fragments in the upper layers, while those inland on Merritt Island (e.g., Paola and Pomello) do not. The presence of shell fragments influences soil nutrient levels, particularly calcium and magnesium, and pH. The eastern and western sections of Merritt Island differ in age. The eastern section of Merritt Island inland to about State Route 3 has a marked ridge-swale topography presumably retained from its formation as a barrier island; west of State Route 3, the island is flatter, without obvious ridges and swales probably due to the greater age of this topography.

Differences in age and parent material account for some soil differences, but on landscapes of Merritt Island with similar age, topography has a dramatic effect on soil formation. Relatively small elevation changes cause dramatic differences in the position of the water table that, in turn, affect leaching, accumulation of organic matter, and formation of soil horizons. In addition, proximity to the lagoon systems influences soil salinity.

Fifty-eight soil series and land types have been mapped at KSC (Ref. 3 and 4). These are listed and described in Appendix A.

Five general soil associations have been identified in the Brevard County section of KSC (Ref. 3). These associations are: Paola-Pomello-Astatula, Canaveral-Palm Beach-Welaka, Myakka-Eau Gallie-Immokalee, Copeland-Wabasso, and Salt Water Marsh-Salt Water Swamp. The Paola-Pomello-Astatula association consists of nearly level to strongly sloping, excessively to moderately drained soils that are sandy throughout the profile. In the KSC area, these soils are found on long, narrow ridges between the Indian and Banana Rivers and along the Kennedy Parkway. The Canaveral-Palm Beach-Welaka Association includes soils that are nearly level to gently sloping, moderately well drained to excessively drained and sandy throughout, that occur primarily on the outer barrier island and Cape Canaveral. The Myakka-Eau Gallie-Immokalee association consists of nearly level, poorly drained soils, sandy throughout to a depth of 102 cm (40 in) and loamy below; these soils are associated with flatwoods vegetation. The Copeland-Wabasso association includes soils that are nearly level, very poorly drained to poorly drained, sandy to depth of 102 cm (40 in) and loamy below; these soils are associated with hammock vegetation. The Salt Water Marsh-Salt Water Swamp association consists of nearly level, very poorly drained, saline to brackish soils of variable textures; these soils are associated with salt marsh and mangrove vegetation. Similar, but differently named, soil associations have been mapped in the Volusia County section of KSC (Ref. 4).

These soil associations are too generalized for many purposes, but there are too many soil series and land types to treat each individually. As part of the recent baseline characterization of soil, groundwater, surface water and sediment of KSC, 10 soil classes were developed (Ref. 6 and 7). First, soils were divided into four groups: (1) upland, (2) wetland, (3) agricultural, and (4) disturbed. Upland soils are not flooded for substantial periods, while wetland soils have standing water for substantial periods. Flooding affects organic matter accumulation, oxidation-reduction conditions, and other chemical properties of soils (Ref. 8). Then upland soils were divided into well-drained and poorly drained categories. Poorly drained soils accumulate more organic matter, which forms the cation exchange capacity in these soils retaining nutrients and metals (Ref. 9, 10, and 11). Well-drained, upland soils were divided into three classes: 1) geologically recent, alkaline, sandy soils of coastal dunes where the vegetation is coastal dunes, coastal strand, or coastal scrub; 2) old, inland, leached, acid, sandy soils where the vegetation is oak-saw palmetto scrub or scrubby flatwoods; and 3) inland, circumneutral soils formed over coquina where the vegetation is oak-saw palmetto scrub or xeric hammock. Poorly-drained, upland soils were divided into two classes: 1) acid, sandy soils with flatwoods vegetation; and 2) circumneutral to alkaline soils formed over coquina or limestone where the vegetation is mesic hammock (Table 5-1).

The primary division of wetland soils was between: 1) inland, freshwater wetlands where the vegetation was freshwater marshes or hardwood swamps; and 2) coastal, brackish to saline wetlands where the vegetation was salt marshes or mangroves (Table 5-1).

Agricultural soils were of two types: 1) active or abandoned citrus on scrub soils; and 2) active or abandoned citrus on hammock soils (Table 5-1). Disturbed soils included various types modified by construction (Table 5-1). This group could be heterogeneous, but there was no apparent division into homogeneous subgroups.

Table 5-1. Soil Classification for Kennedy Space Center.

Division	Subdivision	Description	Class
Upland	Well-drained	Recent, coastal, alkaline soils – vegetation is coastal dunes, coastal strand, or coastal scrub	Coastal
		Old, inland, acid soils – vegetation is scrub or scrubby flatwoods	Acid Scrub
		Inland, circumneutral soils over coquina – vegetation is scrub or xeric hammock	Coquina Scrub
	Poorly-drained	Acid, sandy soils – vegetation is flatwoods	Flatwoods
		Circumneutral to alkaline soils over coquina or limestone – vegetation is hammock	Hammocks
Wetland	Freshwater	Inland, freshwater soils – vegetation is freshwater marshes or hardwood swamps	Freshwater Wetland
	Saline	Coastal, brackish to saline soils – vegetation is saltmarsh or mangroves	Saltwater Wetlands
Agricultural	Scrub soil	Active or abandoned citrus on acid or coquina scrub soils	Citrus Scrub
	Hammock soil	Active or abandoned citrus on hammock soils	Citrus Hammock
Disturbed		Soils modified by construction or filling	Disturbed

(Soils are grouped into 10 classes based on similarities (Ref. 7).

The division of soil series and land types into these classes is given in Appendix A, Table A-2. There are clear landscape patterns to these soil classes (Figure 5-1). Flatwoods, salt water wetlands, and freshwater wetlands were the largest categories (Table 5-2). These soil classes were shown to be significantly different for many chemical and physical parameters (Ref. 6 and 7).

Table 5-2. Area of Soil Classes[1].

Soil Class	Area (hectares)	Percent of Soil Area
Coastal	1098.3	3.30
Acid Scrub	1556.9	4.76
Coquina Scrub	270.4	0.81
Flatwoods	10432.6	31.32
Hammocks	1990.1	5.97
Freshwater Wetlands	6154.3	18.48
Saltwater Wetlands	9626.2	28.90
Citrus Scrub	349.3	1.05
Citrus Hammock	640.0	1.92
Disturbed	1192.4	3.58

[1]Ref. 7.

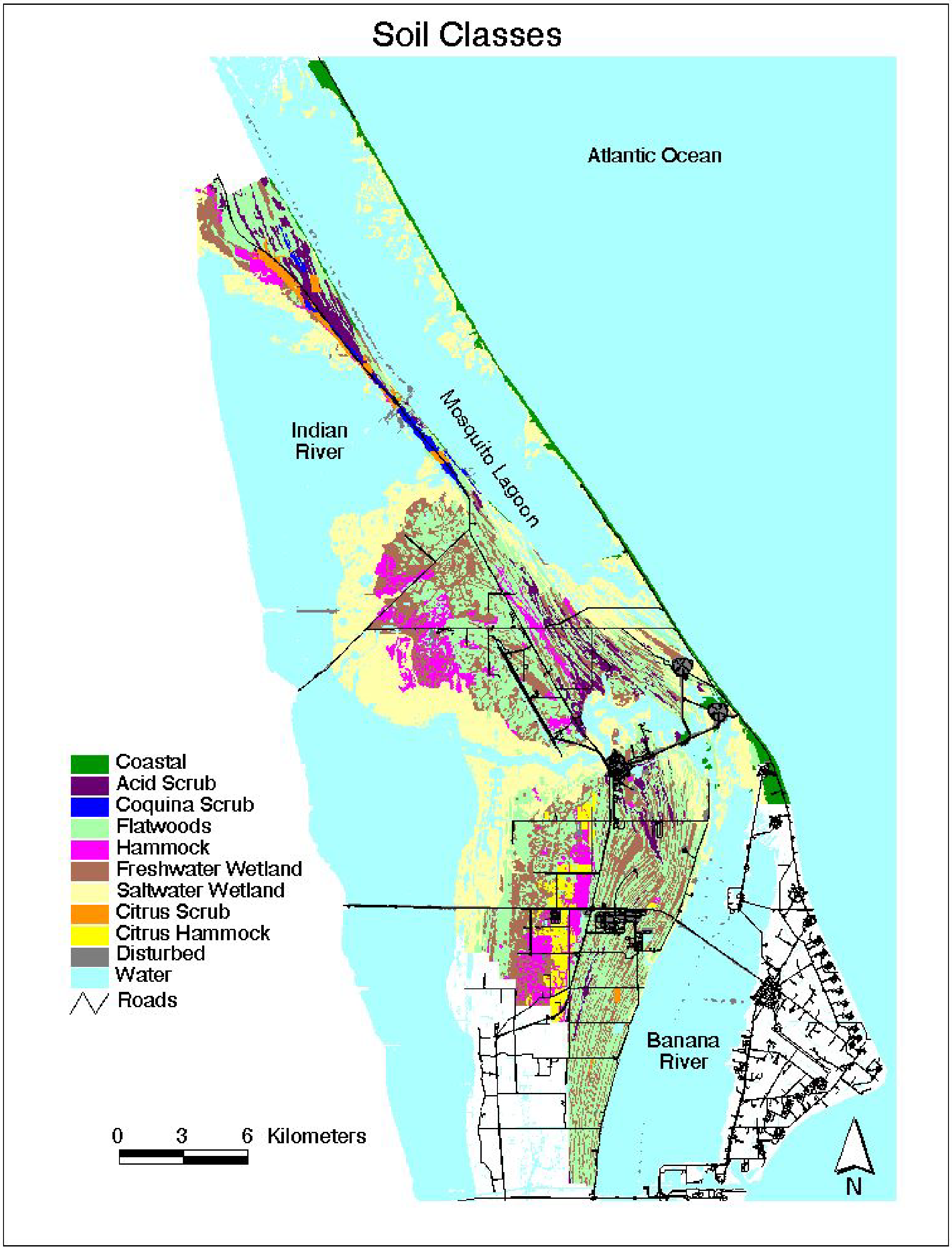

Figure 5-1. Distribution of Soil Classes on KSC (Ref. 7).

5.2 GEOLOGY AND GEOLOGICAL HISTORY

Florida has a complex geologic history with repeated periods of deposition when the Florida Plateau was submerged and erosion when the seas recessed (Ref. 12 and 13). The oldest formations known to occur beneath Brevard County and KSC were deposited in the early Eocene in an open ocean (Ref. 14). This was followed by a withdrawal of the sea and a period of erosion. In the late Eocene, the seas advanced and limestones of the Ocala group were deposited (Ref. 14). Following another period of recession of the sea and erosion of the land surface, the Hawthorn formation of calcareous clay, phosphatic limestone, phosphorite, and radiolarian clay was deposited in the late Miocene (Ref. 14 and 15). Overlying this are unconsolidated beds of fine sand, shells, clay, and calcareous clay of late Miocene or Pliocene age (Ref. 15). Surface strata in Brevard County are primarily unconsolidated white to brown quartz sand containing beds of sandy coquina of Pleistocene and Holocene age (Ref. 15).

During the Pleistocene (ca. 1.6 million years before present [yr B.P.] to 13,000 yr B.P.), repeated glaciation of the northern hemisphere produced fluctuations in sea level (Ref. 16). At the maximum of the Wisconsinan glaciation (ca. 18,000 yr B.P.), sea levels were on the order of 100 m (328 ft) lower than at present, and substantial additional areas were exposed along the Atlantic and Gulf coasts, including Florida (Ref. 17 and 18**).**

The alternating high and low sea stands of the Pleistocene and Holocene (since ca. 13,000 yr B.P.) shaped the surface of Brevard County. The outer barrier island and Cape Canaveral formed after sea levels rose when the Wisconsinan glaciers retreated (Ref. 19). Cape Canaveral is mapped as Holocene in age (Ref. 20). Brooks (Ref. 21) suggested that the formation of the Cape Canaveral peninsula began about 7,000 years ago. Cape Canaveral is part of a prograding barrier island complex, the result of southward growth of an original cape at the site of the present False Cape (Ref. 22 and 23). Multiple dune ridges on Cape Canaveral suggest that periods of deposition and erosion alternated (Ref. 24). The barrier island separating Mosquito Lagoon from the Atlantic Ocean also originated about 7,000 years ago (Ref. 25). However, its history has been marked by erosion, overwash, and landward migration rather than progradation; these processes continue today (Ref. 25). Some areas of the barrier island south of Cape Canaveral have a history of overwash, while others have been more stable (Ref. 26).

Merritt Island also formed as a prograding barrier island complex; the eastern edge of Merritt Island at its contact with the Mosquito Lagoon and the Banana River forms a relict cape aligned with False Cape (Ref. 22 and 23). Multiple dune ridges apparently represent successive stages in this growth. Brooks (Ref. 21) suggested that the geologic history of the Merritt Island-Cape Canaveral barrier island was complex. The western portion of Merritt Island is substantially older than the east (Ref. 21 and 27). Erosion has reduced the western side to a nearly level plain (Ref. 15).

5.2.1 STRATIGRAPHY

Lithology, stratigraphy, and geologic structure are important controls of (1) groundwater quality, (2) distribution of aquifers and confining beds, and (3) the availability of groundwater. Four distinct geologic units are characteristic of the coastal area of East-Central Florida and lie beneath KSC (Table 5-3). In descending order these are: Pleistocene and Recent age sands with interbedded shell layers, Upper Miocene and Pliocene silty or clayey sands, Central and Lower Miocene compacted silts and clays, and Eocene limestones (Ref. 28). North-south and east-west geological cross sections (Figures 5-2, 5-3, and 5-4) were developed by Edward E. Clark Engineers-Scientists, Inc. (Ref. 28) based on data collected during the construction phase of facilities for the Manned Lunar Landing Program at Merritt Island and Cape Canaveral, Florida.

Table 5-3. Generalized Stratigraphy at Kennedy Space Center[1].

Geologic Age	Formation Name	Aquifer	Physical and Water Bearing Characteristics
Holocene			Highly variable and undifferentiated deposits.
Pleistocene	Anastasia Formation	Surficial Aquifer System	Sand, shell, clay, coquina, and mixtures. Yields moderate amounts of water, depending permeability of deposits.
Pliocene	Tamiami Formation		Interbedded limestone, coquina, sand and clay (eastern). Shell, sand, clay and cemented zones (western).
Miocene	Hawthorn Formation	Intermediate Confining Unit	Sand clay, green and brown clays, and some limestones. Generally impermeable; poor water yield except for some thin shell and limestone beds.
Oligocene	Suwanee Limestone	Floridan Aquifer System	Gray to cream colored, clayey, granular limestone. Poor water yields.
Eocene	Ocala Limestone		Gray to cream colored, porus massive limestone, generally yields good quantity of water.
	Avon Park Limestone		Cream colored to tan, porous, chalky, and hard crystalline limestone and dense dolomite.
	Lake City Limestone		Cream colored to tan, porous, chalky, and hard crystalline limestone and dense dolomite.
	Oldsmar Limestone		Not commonly tapped by wells.

[1]Ref. 29.

5.2.2 PLEISTOCENE AND RECENT DEPOSITS

The Pleistocene period was characterized by a wide range of sea level fluctuations. These deposits are, therefore, characterized by 10.7 to 13.7 m (35 to 45 stratigraphic ft) of fine-medium sands with varying amounts of shell and interbedded layers of shell deposited by long shore currents and wave action (high energy environments) and subjected to varying degrees of oxidation. The upper limits of Pleistocene deposits range from 1.5 to 2.4 m (5 to 8 ft) above mean sea level (MSL) or the elevation of the Silver Bluff terrace, the youngest terrace formed as

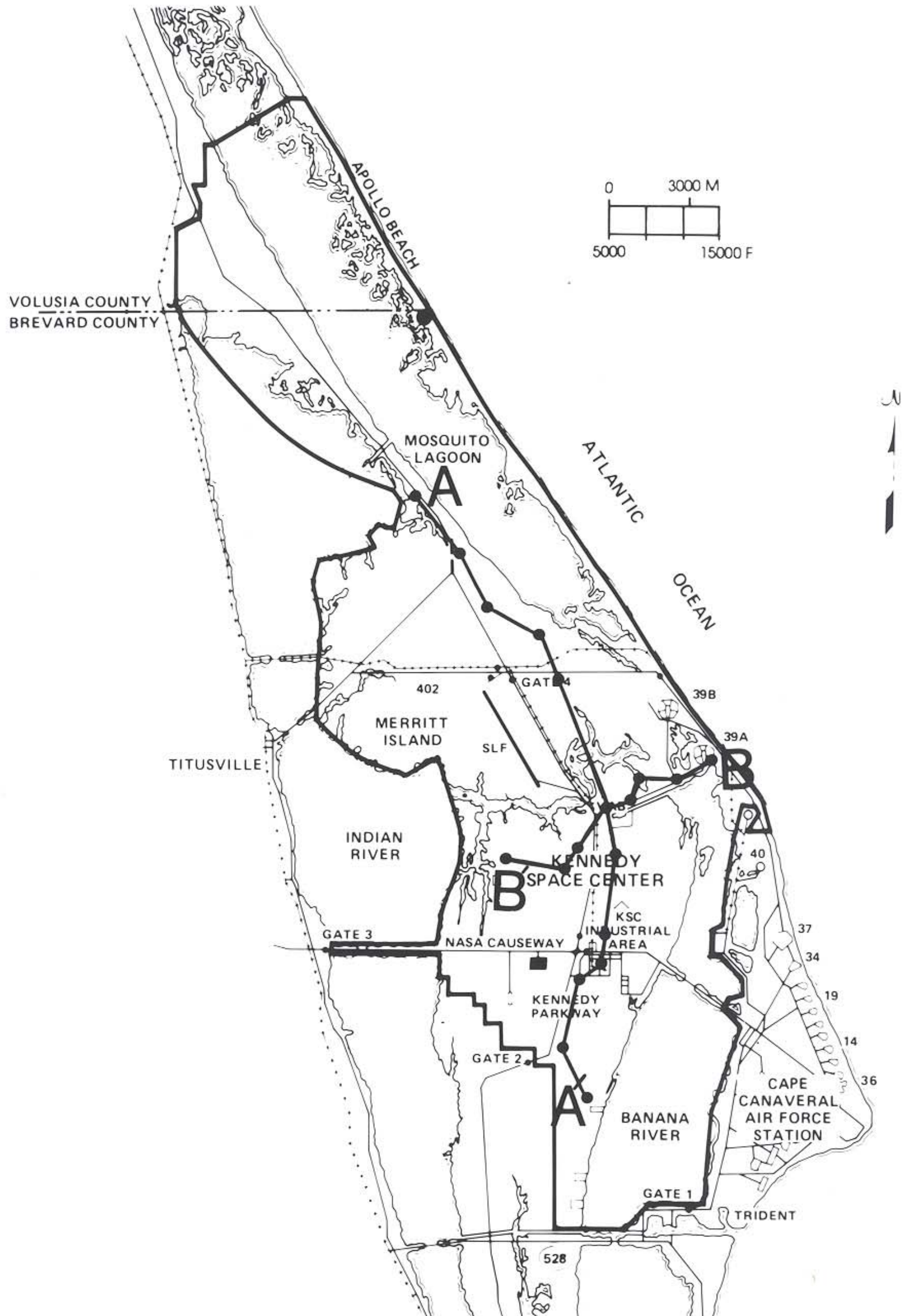

Figure 5-2. Location of North-South and East-West Geologic Cross Sections on Kennedy Space Center (Ref. 28).

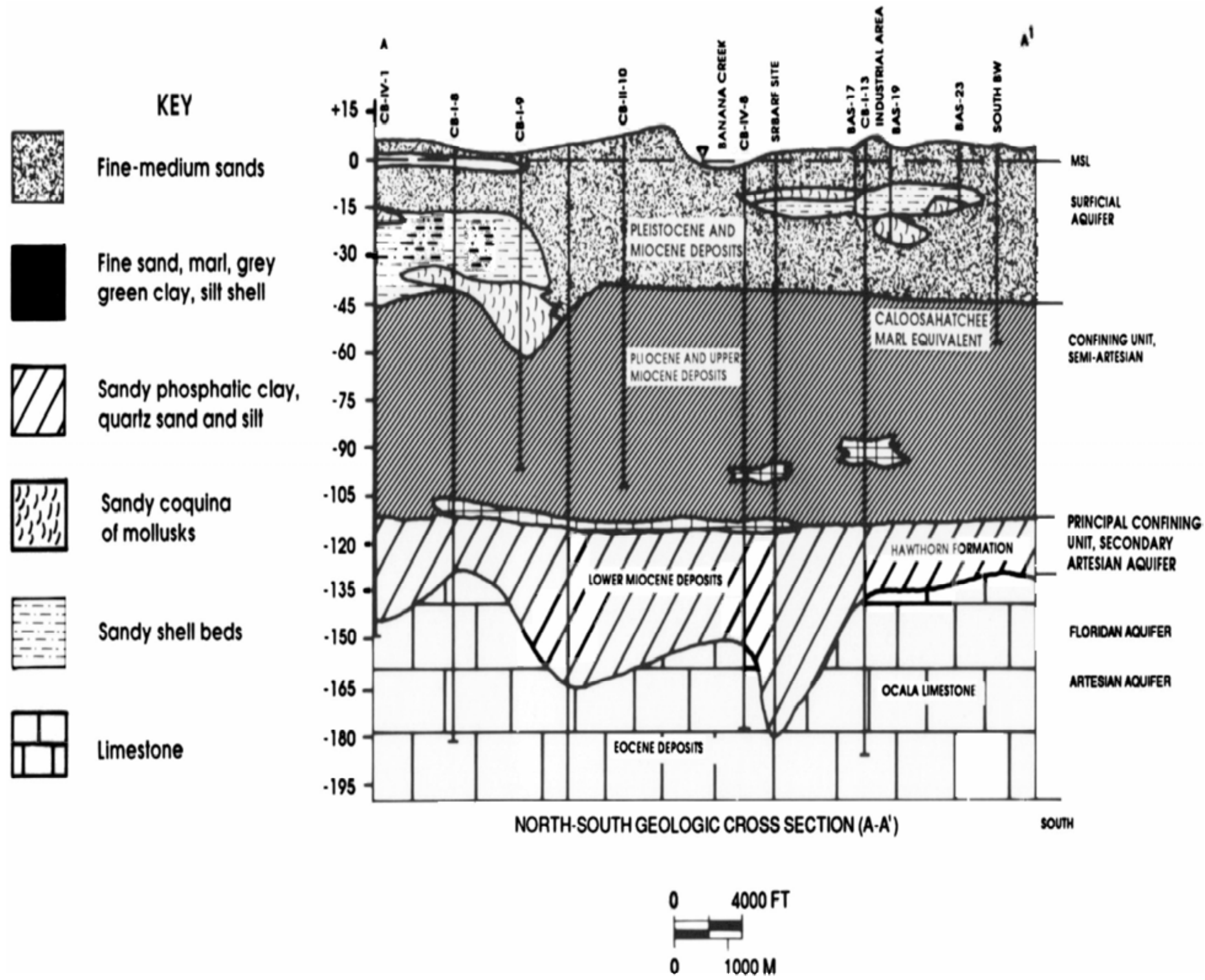

Figure 5-3. North-South Geologic Cross Section for KSC. (Ref. 28). Vertical Scale is Elevation in Feet Relative to Mean Sea Level.

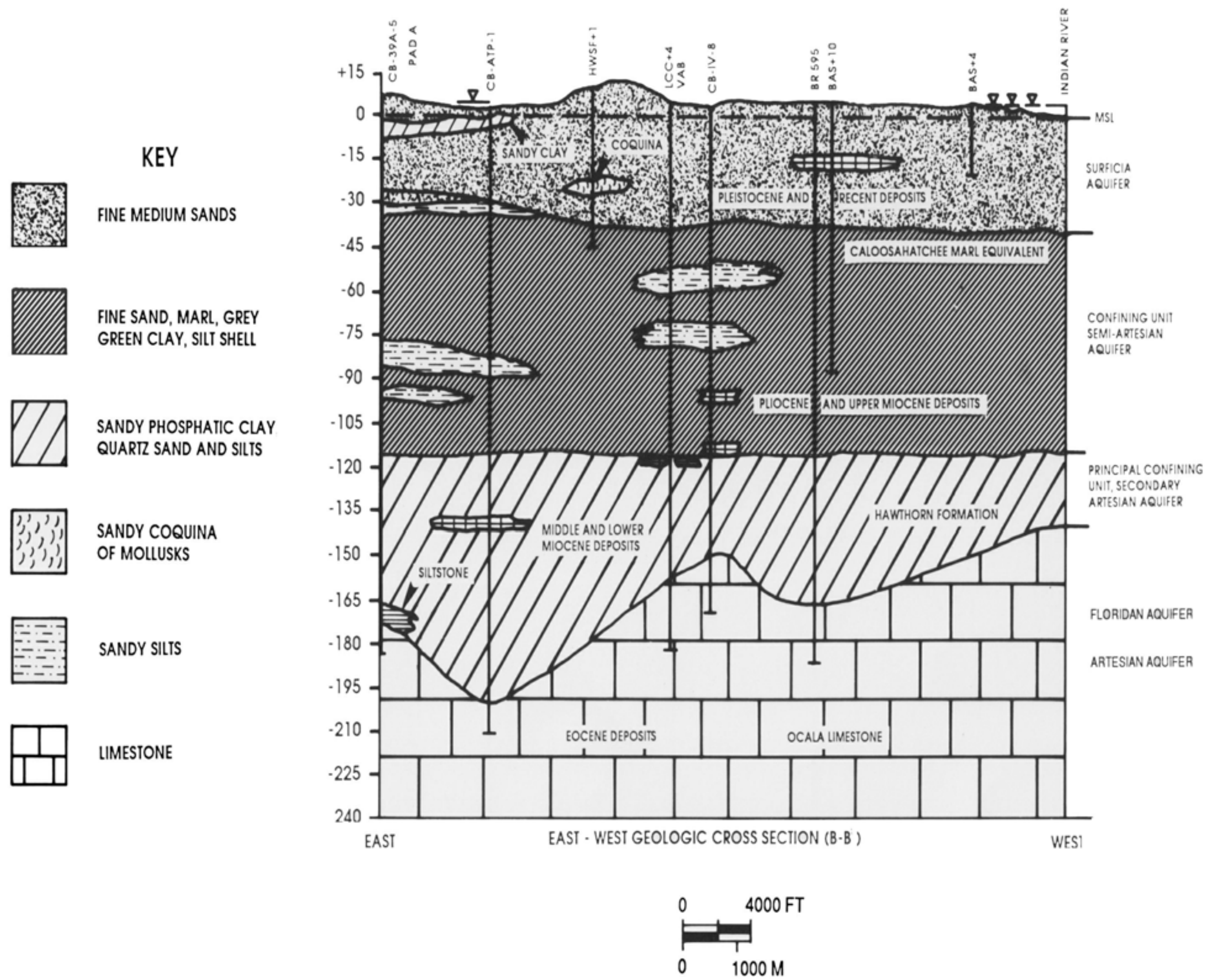

Figure 5-4. East-West Geologic Cross Section for KSC.
(Ref. 28).
Vertical Scale is Elevation in Feet Relative to Mean Sea Level.

the result of the Pleistocene age sea level fluctuation (Ref. 15). The characteristics of these Pleistocene deposits have been altered by cementation and compaction; in the upper horizons discontinuous layers of limerock hardpan, dark brown humic sandstone hardpan, silt, and clay can be found (Ref. 28).

5.2.3 UNDIFFERENTIATED UPPER MIOCENE AND PLIOCENE SILTS, SANDS, AND CLAYS

Visually there is little difference between the upper Hawthorn and Upper Miocene deposits. These deposits, generally occurring between a top elevation of -9.1 m (-30 ft) MSL and a base elevation of -35 m (-115 ft) MSL, consist primarily of sands, silts, and clays with minor occurrences of limestone and shelly sands. They were deposited in shallow marine and lagoonal environments subjected to numerous sea level fluctuations resulting in numerous interbedded, discontinuous strata of local area extent. The upper limits of these undifferentiated deposits are equivalent to the Caloosahatchee Marl Formation and, in the northern extremities of Merritt Island; the top of the Pliocene Tamiami Formation is at approximately –26.5 m (-87 ft) MSL. Within the Tamiami Formation lies a narrow band of shelly conglomerate or medium hard limestone. The contact between the undifferentiated sediments and the overlying surficial sands is conformable and gradational over approximately 0.9 m (3 stratigraphic ft), but is nonetheless distinct (Ref. 28).

5.2.4 LOWER AND MIDDLE MIOCENE SILTS AND CLAYS

The Ocala limestone was submerged during the Miocene Epoch at which time the Hawthorn Formation was uniformly deposited on the karst Ocala limestone surface. The top of the Hawthorn Formation is located approximately -35 m (-115 ft) MSL and extends down to the Ocala limestone. It consists of calcareous clays and silts, sandy phosphatic limestone, and phosphatic clays. Varying amounts of phosphatic material (formed from residue of shallow marine life) and a dramatically high natural gamma ray signature on geophysical well logs are identified as massive beds of marine clays and silts. Associated with this formation are at least two thin (approximately 0.6 to 0.9 m [2-3 ft]), discontinuous conglomerate limestone/ sandstone beds. The upper bed, although not always present, is located near the -36.6 m (-120 ft) MSL mark and the location of the lower bed ranges between approximately -39.6 m (-130 ft) MSL and -42.7 m (-140 ft) MSL depending on the presence or absence of faulting. Its thickness depends on the extent to which the Ocala limestone surface has been eroded. The top of the Hawthorn Formation gradually changes to Upper Miocene silts and clays. The exact upper limits of the formation have not been described; however, it is assumed to be the change from firm compact sediments to looser, less consolidated materials. Numerous geophysical logs (natural gamma) indicate the diagnostic signatures of the Hawthorn Formation beginning approximately -33.5 m (110 ft) MSL to -36.6 m (-120 ft) MSL (Ref. 28).

5.2.5 EOCENE LIMESTONES

At least four limestone formations from the Eocene Epoch make up the Floridan aquifer system in the KSC area (ref. Table 5-3). The upper limestones, the Ocala group, are the best defined as they have been test drilled numerous times for the design of facilities for the Manned Lunar

Landing Program and have been utilized for an artesian water source. The Ocala limestone is of late Eocene age and was formed in a shallow sea environment. This limestone was later exposed to subaerial processes above sea level where it developed a karst topography with sinks, cavities, and solution channels (Ref. 28).

5.2.6 TEST DRILLING AND OTHER GEOLOGIC RELATED STUDIES

During the construction phase of facilities for the Manned Lunar Landing Program at Merritt Island and Cape Canaveral, Florida, the Army Corps of Engineers (COE) documented numerous geology and soils reports with emphasis on general and detailed foundation information. These reports can be found in the KSC Technical Documents Library.

5.2.7 SEISMOLOGY

Seismological investigations of the Cape Canaveral area included refraction surveys and well logs. The investigations were conducted by the Seismological Branch of the U.S. Coast and Geodetic Survey and showed that the Cape Canaveral underground structure is normal and free of voids or anomalies. The Florida Platform exhibits high seismologic stability with very few confirmed earthquakes (Ref. 30).

5.3 VEGETATION AND LAND COVER

The 1995 vegetation and land cover map prepared for the St. John's River Water Management District was used as the basis for the vegetation and land cover map presented here (Figure 5-5, Table 5-4). The original map used the Florida Land Use Cover and Forms Classification System (FLUCCS, Florida Department of Transportation 1999). The classification was simplified for presentation here, and some corrections to the base coverage were made. However, the extent of corrections was limited and no groundtruthing or accuracy assessment of this map has been conducted.

Table 5-4. Land Cover Classes on Kennedy Space Center.

Land Cover Class	Area (ac)	Area (ha)
Upland Vegetation	41083	16625
Wetland Vegetation	36183	14642
Urban and Developed	3800.3	1537.9
Water	54228.1	21945.4

Derived from 1995 St. John's River Water Management District map with modifications.

5.3.1 UPLAND VEGETATION

These types are natural communities occurring on sites that are not flooded for extended periods. Minor areas of wetlands may be included in these mapping units. The types of habitats found in these areas include: scrub, flatwoods and hardwoods and mixed forests. Wetland Vegetation – These types are natural communities that occur on sites that are flooded for short-to-long periods in most years. Minor areas of uplands may be included in these mapping units. The types of habitats that are found in these areas include: freshwater marshes, hardwood and mixed swamps,

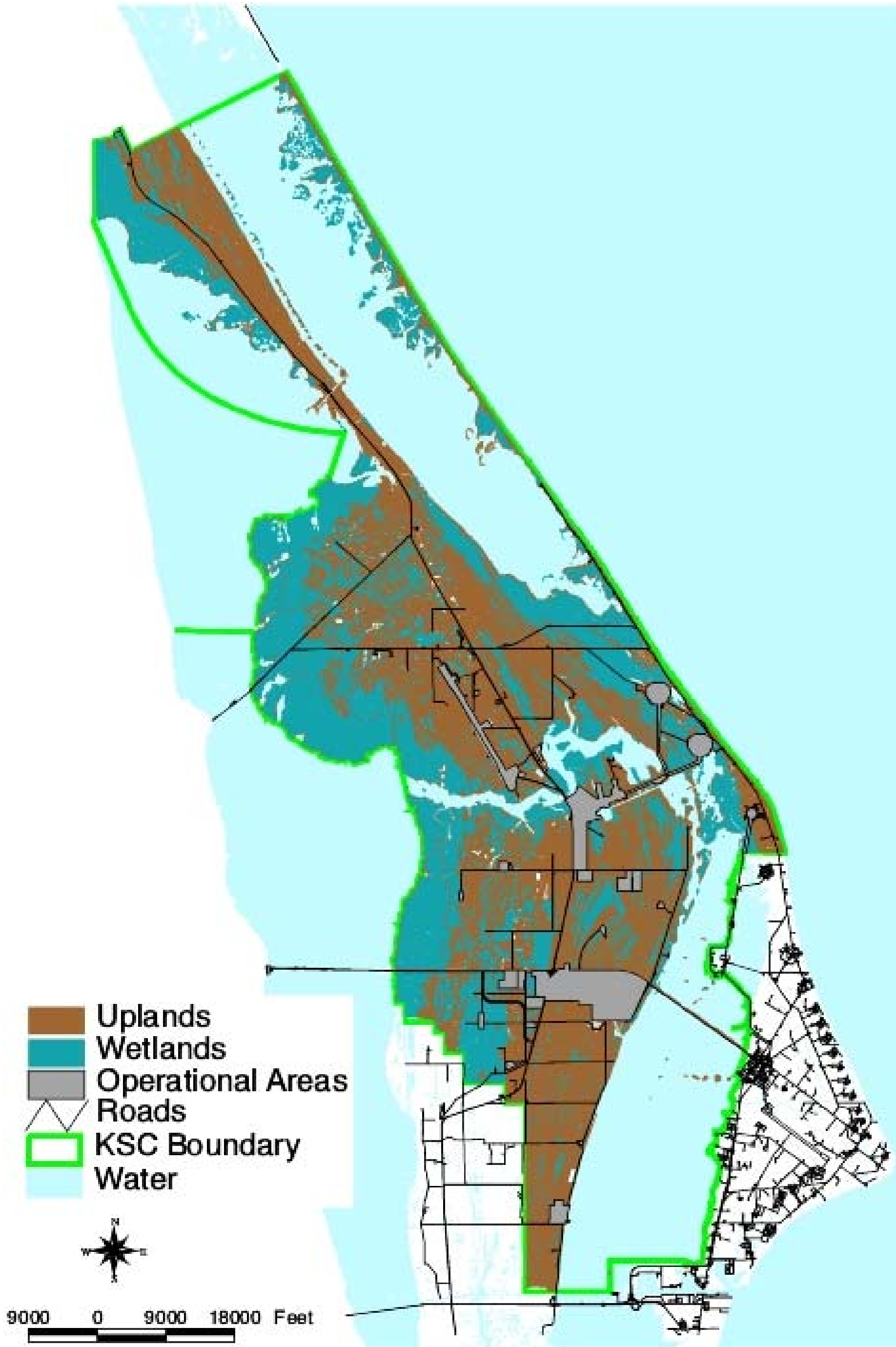

Figure 5-5. General Land Cover on Kennedy Space Center.

wetlands shrub, saltwater marshes, and mangrove swamps. More details of these habitats can be found in Section VI, Natural Resources. Also found there is a more detailed map of these areas.

5.4 LAND USE, MANAGEMENT AND PLANNING

NASA exercises control over the 56,449 ha (139,490 ac), which comprise KSC. The overall land use categories and land management objectives of NASA and KSC are to maintain the Nation's space mission operations, while supporting alternative land uses that are in the Nation's best interest. All zoning and land use planning is under NASA directive for implementation of the Nation's Space Program. Land use at KSC is carefully planned and managed to provide required support for missions and to maximize protection of the environment. Essential safety zones, clearance areas, lines-of-sight, and other such elements have been developed as guides to master planning and, where applicable, as mandatory operational requirements. All facility sitings and projects are reviewed extensively with attention to items described in this section. For areas not directly utilized for NASA operations, land planning and management responsibilities have been delegated to the National Park Service (NPS) and the USFWS (see Figure 5-5). These agencies exercise management control over agricultural, recreational, and environmental programs at KSC.

5.4.1 LAND USE

Undeveloped lands dominate KSC. Undisturbed areas including uplands, wetlands, mosquito control impoundments, and open water areas, comprise approximately 95 percent of the total KSC area (see Figure 5-6). Nearly 40 percent of KSC consists of open water areas including portions of the Indian and Banana Rivers, Mosquito Lagoon and all of Banana Creek.

NASA maintains operational control over approximately 1,704 ha (4,212 ac) of KSC. This area comprises the functional area, which is dedicated to NASA operations (see Figure 5-6). The NASA operational areas contain currently developed facility sites, roads, lawns, and maintained right-of-ways. The remaining undeveloped operational areas are dedicated as safety zones around existing facilities or held in reserve for planned and future expansion.

Developed facilities within the NASA operational area are dominated by the Shuttle Landing Facility, the Industrial Area, and the VAB Area (see Figure 5-6).

These facilities comprise more than 70 percent of the NASA operational area. The remainder of the NASA operational area is divided among smaller facilities spread throughout KSC.

The 54,745 ha (135,278 ac) outside of NASA operational control are managed by NPS and USFWS. NPS administers a 2,693 ha (6,655 ac) area of the CNS (56,449 ha [57,600 ac] total), while USFWS administers 20,616 ha (50,945 ac) of the CNS and the 30,506 ha (75,383 ac) of the Merritt Island National Wildlife Refuge (MINWR).

Major municipalities outside of, but near KSC, include the City of Titusville, which is approximately 15.2 km (9.5 mi) from the KSC Industrial Area and the City of Cape Canaveral, which is approximately 13.6 km (8.5 mi) from the KSC Industrial Area.

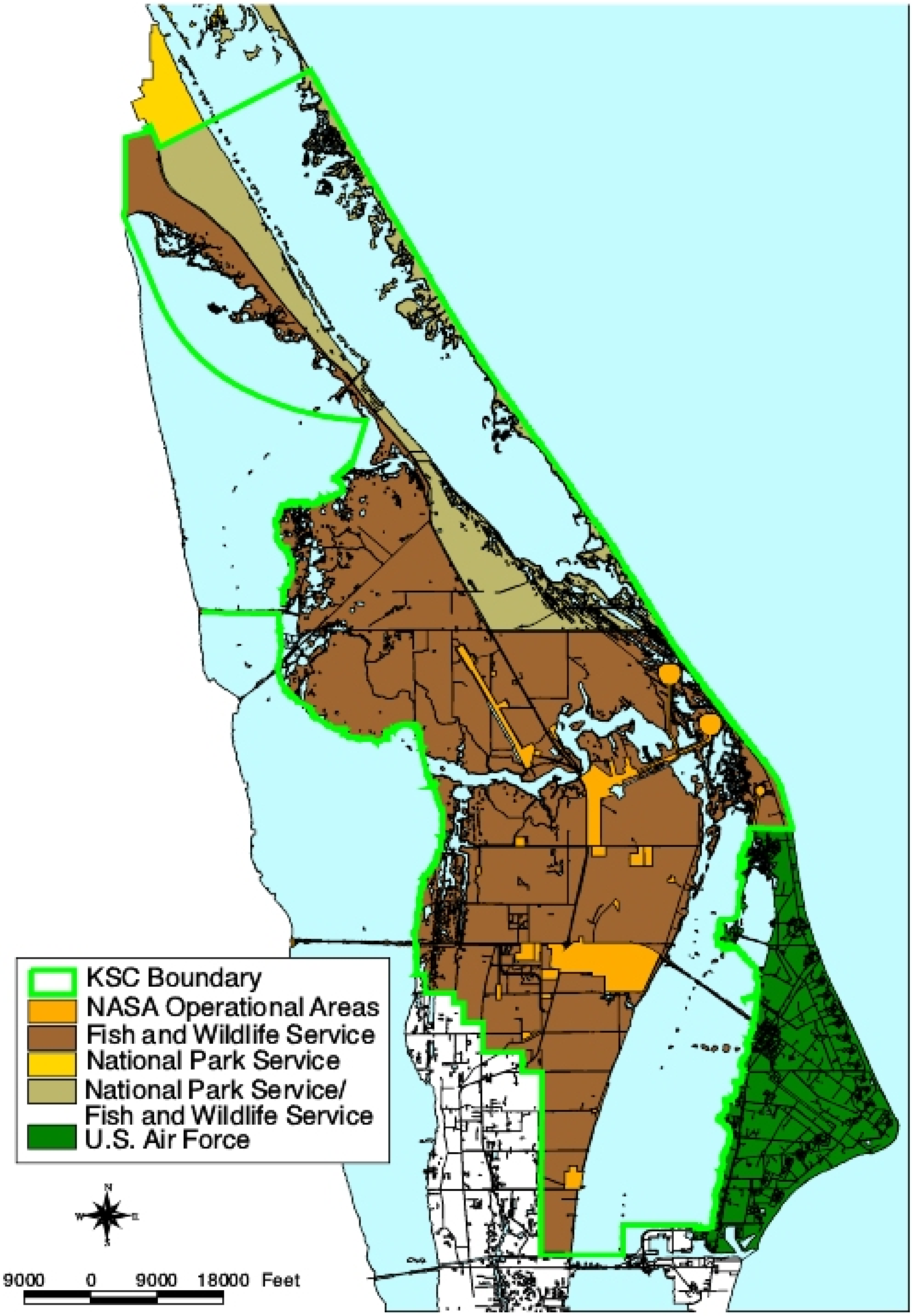

Figure 5-6. KSC Administrative Areas.

5.4.2 LAND USE CATEGORIES

NASA has devised 11 land use categories to describe the regions within, which various types of operational or support activities are conducted.

Launch. The Launch (LA) land use classification includes all facilities directly related to vehicle launch operations and is subdivided into horizontal launch and vertical launch subcategories. Vertical launch includes the launch pad and immediately adjacent terminal countdown facilities required to be operational at the time of a launch. Horizontal launch includes areas required for the paved runway surface, guideway or similar facility, together with land reserved for safety zones, parallel with and at each end of the launch facility, consistent with the most restrictive Federal Aviation Administration (FAA) clearance requirements for commercial runways. Quantity distance (QD) arcs, transitional surfaces and other related safety setback and exposure limits are considered restrictions on the use of land adjacent to the space launch complexes. Land within those setbacks and limits is not designated part of the Launch and use.

Launch Support. The Launch Support (LS) land use classification includes all facilities and operations not classified as Launch, that are essential to processing and launching a vehicle from the Spaceport, recovering and processing a vehicle returning to the Spaceport, and supporting a mission during flight. Launch Support also includes all facilities (regardless of function) not classified as Launch, that are directly related to a specific program at the Spaceport. An example would be management or research and development facilities dedicated to the Space Shuttle Program.

Airfield Operations. The Airfield Operations (AO) land use classification includes runways and helipads. It also includes adjacent open areas and related support facilities used for takeoff and landing of conventional aircraft in support of Spaceport or program-related operations or for commercial purposes. Facilities in this land use classification would include the Skid Strip (if not designated a horizontal launch/recovery test facility) and various heliports located throughout the Spaceport. Imaginary surfaces related to airfield operational clearances and QD arcs and other related safety setback and exposure limits are considered restrictions on the use of land adjacent to Airfield Operations areas. Land within those surface areas, setbacks and limits, are not designated as part of the Airfield Operations land use.

Spaceport Management. The Spaceport Management (SM) land use classification includes all administrative functions that provide for management and oversight of Spaceport operations, plus the services administered by those managing entities for the benefit of the overall Spaceport complex, including operations and maintenance, service and utilities, and infrastructure. Examples of administrative land uses include KSC and CCAFS administrative headquarters, child development and care, training and conference, dispensary, data processing, environmental and occupational health, food service and photo operations facilities. Examples of operations and maintenance land uses include base operations, base support, base electric shop, corrosion control, central supply, facilities maintenance, motor pool, service station, NASA Railroad, reclamation areas, roads and grounds maintenance, and sanitary landfill facilities. Examples of service land uses include entry gates and access control, fire stations, fire and rescue training, security, and security training facilities. Examples of utilities and infrastructure land uses include areas designated as primary transportation corridors for arterial roadways, land required for utility service complexes, such as electrical substations and co-generation plants or sewage and water treatment facilities, but not utility easements or right-of-ways, and engineered water storage areas constructed as part of the stormwater management system.

Research and Development. The Research and Development (R&D) land use classification includes laboratories and related facilities that perform testing and experimentation for the purpose of developing new programs and technologies at the Spaceport. R&D may also include educational institutions offering advanced degrees in disciplines supporting Spaceport R&D activities. Examples of R&D land uses include chemical, physical standards and laser testing laboratories; missile research and testing facilities; centers for experimentation; innovative science and technology; and life sciences. Laboratory, testing, and other related functions, that support the operations of a specific established program at the Spaceport, are classified as Launch Support land uses related to that specific program.

Public Outreach. The Public Outreach (PO) land use classification designates facilities that provide an informational or educational connection between the Spaceport and the community. Examples of PO land uses would include welcome centers, public reception, education and display areas, hotels/motels and conference centers, museums, memorials, media centers, tour facilities and launch viewing areas.

Seaport. The Seaport (SE) land use classification includes wharves used for the docking of vessels and facilities, that directly support wharf operations. Examples of wharf operations include the Vehicle Assembling Building (VAB) basin at KSC and the Hangar AF wharf at CCAFS, which support NASA programs. Military wharf facilities at Port Canaveral support Air Force programs and cargo/supply operations, commercial EELV programs and the Navy Poseidon and Trident wharves. Also included in the SE classification are Naval Ordnance Test Unit (NOTU) facilities located throughout the south gate area, which operate in support of the Poseidon and Trident wharves.

Recreation. The Recreation (RE) land use classification includes parks, outdoor fitness areas, athletic fields, recreation buildings, centers and clubs within the Spaceport complex. Examples of RE land uses and facilities include KARS Park and KARS Park II complexes, fitness circuits, recreation centers and gymnasiums, athletic fields and recreation or leisure clubs. Coastal beaches and supporting facilities are part of the Canaveral National Seashore (CNS) and are classified as conservation areas. Camping, fishing, picnic and related outdoor activity areas associated with the MINWR are also classified as conservation areas.

Conservation. The Conservation (CO) land use classification includes all natural areas and all undeveloped land not assigned to another land use classification. The CO classification is divided into two sub-classifications: wildlife refuge, which includes all natural and undeveloped land and impoundment areas, and bodies of water, which includes all defined water bodies within Spaceport property. Land within the CNS and the MINWR is included in the CO land use classification. Facilities that support the administration, maintenance and enjoyment of conservation areas are classified as part of the conservation area in which they are located.

Agriculture. The Agriculture (AG) land use classification includes land areas used for the cultivation of crops or plant material for commercial purposes or for Spaceport facility landscape maintenance. Examples of existing agricultural land uses within the Spaceport include active and abandoned citrus groves and plant nurseries.

Open Space. The Open Space (OS) land use classification includes undeveloped open land within developed activity centers identified as likely for future development. The criteria for OS includes existing land that is primarily cleared of natural vegetation, leveled, and located in or immediately adjacent to developed activity centers, where future expansion of existing facilities may be anticipated.

For a map of the Cape Canaveral Spaceport's current land use categories, link to GIS Spaceport Map View at http://gis.ksc.nasa.gov.

The Launch Impact Zone extends from the Shuttle launch pads to the Launch Impact Limit Line and into the Atlantic Ocean. High sound-pressure levels occur within this zone and personnel are excluded from this zone during launch events. Launch Complexes 39A and 39B, direct launch support structures, remote controlled optical and electronic instrumentation facilities, and launch support facilities are sited within this zone. Areas have been reserved for future expansion (Ref. 31).

Various degrees of launch hazards are generated at KSC during preparation, launch, and flight of a space vehicle. The governing clearance is the maximum of all clearances for any one time. Hazard clearances to be considered are for the loss of a vehicle on the pad, hazards associated with a normal launch, and loss of a vehicle after launch.

Flight termination systems are installed on unmanned launch vehicles to minimize the ground area impacted by the loss of a vehicle after launch. An analysis of impact limit lines is prepared for each individual launch.

This analysis considers flight azimuth; vehicle stages, modules, and engines of a space vehicle; wind conditions; turning rates; and trajectory. Such an analysis may dictate impact lines exceeding any other required clearances. These impact limit lines are used in determining approval for building sites.

This zone extends beyond the Launch Impact Limit Line to the General Support Zone. Only those structures required in direct support of launches are located within this area. Structures in this zone may require special design to provide protection from toxic propellants and other hazards. Generally, they are located at prescribed safety distances consistent with inhabitants, materials, and equipment involved. Structures normally located within this zone include:

- Buildings for inspection, assembly, storage and checkout of rockets and related equipment
- Buildings for inspection, checkout, and preparation of Space Shuttles
- Structures related directly to support of launch activities
- Ordinance storage and checkout buildings

- Liquid propellant manufacturing and storage facilities
- Solid propellant manufacturing, inspection, checkout and storage facilities

This zone extends from the Launch Support Zone to the KSC boundaries. Structures located within this area may be manned and are relatively safe from explosions on the pads, acoustic vibrations, and toxic propellant hazards.

This zone contains administrative, logistical, and industrial support facilities. It provides a relatively safe area for large concentrations of people and includes facilities not needed near the launch areas.

5.4.3 SPECIFIC AREA PLANNING ZONES

To support the long-term vision for the Spaceport, Spaceport planning encompassed the landmass of CCAFS as well as KSC. Future development focused on collaboration between the Air Force and NASA in facility planning, with the goal of creating an enhanced and optimized operation, effective communications, and staff productivity for both the military and the civil space programs through the improvement and continued development of Spaceport activity centers. This can be achieved through reorganization and consolidation of appropriate Spaceport functions in each activity center to create improved workplace environments, increasing intensity of development, and optimal use of land resources.

Three activity centers have been identified. Each is planned to support, but not directly perform, the core space launch mission of the Spaceport. Effective site selection for future projects, that is consistent with the Future Land Use Plan for the Spaceport, remains critical to achieve the vision of the Master Plan.

ACTIVITY CENTER 'A' **Area Description:** Activity Center 'A' is a combination of two areas of the Kennedy Space Center: the KSC Industrial Area and the Visitor Center Complex. Both are located central to the Spaceport, immediately south of NASA Causeway and divided by Kennedy Parkway. The adjacency of the two sites, as well as the roadway separating them, is advantageous for the future demands and access issues addressed by the sub-area plan.

The KSC Industrial Area serves a variety of needs for the Kennedy Space Center. With approximately 35 major facilities and numerous other ancillary buildings, this area provides land for activities relating to base operations, utilities, launch support, payload processing, systems testing, and technology R&D. Developed over the last 40 years, this area of the Spaceport has played a critical role throughout the history of the Space Center by providing sites for program-specific activities, as well as, general operations and administrative functions.

The Visitor Center Complex has provided the general public an opportunity to observe and participate in both the history and the future of the U.S. Space Program. Because of the ease of access for the general public and the surrounding fallow orange groves and clear space, this site is ideally located for additional public outreach projects, as well as, commercial developments related to R&D and education.

***ACTIVITY CENTER 'B'* Area Description**: Activity Center 'B' is located on Cape Canaveral in the vicinity of the existing CCAFS Industrial Area. Because Activity Center 'B' is centrally located among the existing vertical launch complexes and adjacent to the Skid Strip, it should continue to be developed and enhanced for direct launch support activities. As with the KSC Industrial Area, this site has been developed over the life of the military and civilian space programs and is currently in use as a predominantly military installation. The existing facilities are aging and were constructed on a program-need basis. A higher-intensity development pattern exists here than at the KSC Industrial Area, promoting better workplace environments and efficient operations. While many facilities will require renovation and program reassignment to meet the goals of the CCSMP, Activity Center 'B' will also witness the construction of new facilities, parking and service amenities, that will infill available sites.

***ACTIVITY CENTER 'C'* Area Description:** Activity Center 'C' is located adjacent to the existing Central and East Turning Basins and includes KSC and CCAFS facilities at Port Canaveral and the South Gate Area. The majority of CCAFS land uses within this area are NOTU and ROCC operations. Built as an industrial area, supporting both military launch capabilities and seaport activities, Activity Center 'C' has been developed to meet various program-specific requirements for the Air Force and Navy. With CCAFS to the north and bounded by water on the remaining three sides, this area has limited roadway access from Port Canaveral to the west and the Air Force Station to the north. The available wharf areas and deep-water basins within Activity Center 'C' offer the only remaining seaport access not currently developed for commercial use in the Port Canaveral area.

Outside the three Activity Centers, planning and facility development will focus on direct support to space missions, including rehabilitation of aging mission support buildings and launch pads, as well as, the construction of new facilities to support advances in technology and new launch programs. Existing launch complexes, particularly those that support programs of limited duration, will be modified and redeveloped to serve emerging launch programs.

Conceptual Security Zones. Maintaining a safe and secure installation is more important and challenging today than ever before. At the same time, it is important for certain areas of the Spaceport to be accessible to the public so the Spaceport may reach out to the community to involve and educate and to encourage a synergistic collaboration involving NASA scientists, private sector researchers and institutions of advanced learning to facilitate the development of new ideas and technologies. The arrangement of Activity Centers and facilities, as outlined in the CCSMP, facilitates the establishment of three graduated levels of security consistent with the functions of the Activity Centers and the overall Space Center.

- **Public security zones** include areas where the public has regular access to facilities and services. Public zones include the Visitor Center/Saturn V Center Complex, the Astronaut Memorial, and the public launch viewing facilities and locations. Also included are the International Space Research Park (ISRP) and the Space Experiment Research and Processing Laboratory (SERPL). Public areas also include CNS and areas of the MINWR north of Titusville Road. Access to public zones would be monitored and facilities maintained so that access could be controlled during times of emergency or program operations requiring more restricted access.

- **Administrative security zones** include areas where access to facilities is controlled and where visitors from outside KSC may be expected on a regular basis. Administrative zones include the Administrative complex and the Development Test Bed complex in the KSC Industrial area. Administrative zones are separated from public zones by a secure perimeter with access controlled via access gates or card control entrances.

- **Operational security zones** include areas dedicated to launch, launch support, space-related operations and all other areas within property boundaries, not included in the public or administrative security zones. Operational zones include, but are not limited to the VAB Area, payload processing facilities in the KSC Industrial Area and on CCAFS, the launch complexes and landing facilities, and those facilities dedicated to instrumentation, navigation and flight tracking. Operational zones are separated from public and administrative zones by a secure perimeter with access controlled via access gates or card control entrances. In addition to supervising the defined security zones, security will monitor the entire perimeter of Federal property.

5.4.4 SPECIFIC EASEMENTS AND RIGHTS-OF-WAY

Easements are provided to utility suppliers such as Florida Power and Light Company easements for power lines. Also included is right-of-way for Southern Bell communication cables. Other uses are the easement used until 1983 by Florida East Coast Railroad and easement for high pressure and natural gas lines. The Center has also granted easements to Cellular Communication Towers to improve the cell phone service.

5.4.5 SPECIFIC ZONES AND CLEARANCES

KSC has been zoned to protect personnel and facilities from launch hazards such as blast forces, acoustic pressures, radio frequency radiation, and laser beams. In addition, restrictions on the development and use of facilities are established based on required clearances for flight hazards, instrumentation lines-of-sight, instrumentation quiet zones, and security. Buildings and structures are sited to provide necessary safety distances. These safety zones or clearances are developed by considering constraints as discussed in the following subdivisions.

5.4.5.1 <u>Radio Frequency Radiation.</u> Radio frequency radiation is a hazard emanating from certain electronic apparatus and is evaluated by measurements taken from operational equipment. It is necessary to rely on separation distance for protection of the public and personnel assigned to work at KSC. This has resulted in the establishment of special radio frequency zones.

5.4.5.2 <u>Blast Forces.</u> Blast hazards are caused by explosion of launch vehicles or ordnance items. The resulting overpressures, expressed in Newtons per square centimeter (N/cm2), vary with distance from the point of explosion. These overpressures can cause damage to structures or other launch vehicles, depending upon their design and the distance separating them from the explosion. Although all blast overpressures are of concern, overpressures of most concern to Master Planning at KSC are regulated as: ordinary building overpressure limit, Shuttle overpressure limit, and property overpressure limit.

5.4.5.3 Laser Beams. The Microwave Scanning Beam Landing System (MSBLS) is calibrated by using a laser device located approximately at the midpoint of the SLF (on the east side). When the MSBLS is being calibrated, personnel access is strictly controlled to prevent exposure to the laser beam.

5.4.5.4 SRB Recovery Area. The SRB Recovery Area is a fan-shaped area offshore from the launch site. Two NASA retrieval vessels maintain surveillance of this zone during the launch-through-splashdown period to warn other vessels in the area.

5.4.5.5 Acoustic Pressures. Acoustic hazards are a result of sound pressure levels generated by high-thrust booster engines. Overall sound pressure levels of 120 and 135 decibels (dB) are the most important sound pressure levels considered in zoning.

Damage to buildings of ordinary construction may occur at sound pressure levels of 135 dB, particularly at the lower frequencies. General support structures will normally be sited at distances to comply with this criterion, or they will be designed to suit the acoustic environment involved. Personnel without ear protection should not be exposed to overall sound pressure levels equaling or exceeding 120 dB (threshold of pain).

5.4.5.6 Toxic Vapors. Toxic vapors from the propellants used in space vehicles may be released into the atmosphere from vehicle explosions, equipment failure during fueling, or similar accidents. If this happens, people in the immediate and downwind areas from the accident will be exposed to toxic fumes. The maximum concentration of toxic fumes to which personnel may safely be exposed depends upon the propellant involved. Buildings not designed to protect occupants from toxic hazards will be evacuated during hazardous operations.

5.4.5.7 Lines-of-Sight. KSC has many transmitters, receivers, camera pads, and visual observation points that result in the requirements for lines-of-sight between various points. Several of these points are on CCAFS. Others are or could be placed on non-government property. Lines-of-sight from optical and electronic instrumentation are considered during the process of reviewing siting projects. Special attention is paid to electronic line-of-sight requirements that may be complicated by structures causing multi-path interferences even when they are outside the line-of-sight.

5.4.5.8 Quality/Distance Radii. Quality/Distances (Q/Ds) show radii for Intraline, Inhabited Buildings, and other related criteria.

These Q/Ds are based on the greatest allowable amount of explosives, solid rocket motors, liquid propellants, or other hazardous materials that may be stored at a facility. The radius distances are calculated from the formulas and tables in the Air Force Regulation 127-100. This regulation implements the Department of Defense (DOD) Ammunition and Explosives Safety Standards outlined in DOD Directive 5154.4-S. These standards also agree with OSHA Standards 1910.109.

5.4.5.9 Airspace. The U.S. Air Force (USAF) and FAA have designated special airspace zones over and around the Shuttle Landing Facility (SLF) and the skid strip on CCAFS to ensure

Shuttle and aircraft safety when landing or taking off. For increased safety, obstructions to flying units are also identified.

5.4.6 LAND USE PERMITS

Special land use permits are considered during review of facility siting requests. Both duration of permit and assignment of permit vary. Three examples of current special land use permits are KARS Park, COE spoil site, and LC-39 press site. A permit has been obtained for a recreation area (KARS Parks I [Complex 99] and II) located on Center property. KSC personnel and their families use these parks. The Corps of Engineers has a permit for a spoil area located on the north bank of the Barge Canal at the southern boundary of KSC. Many of the news media lease areas in the Press Site for newsgathering and broadcasting facilities. Major media leaseholders include ABC, NBC, CBS, CNN and several newspaper organizations.

The Center has formed a partnership with the State of Florida to develop a 161-ha (400-ac), campus-like and ecologically friendly research park with a balanced mix of academic and commercial tenants. In order to take advantage of this established partnership, the Center has replaced a Korean War-era hangar with 9,290 m^2 (100,000 ft^2) facility named Space Experiment Research Processing Laboratory (SERPL), that will be a state-of-the-art laboratories with the capability and systems necessary to host International Space Station experiment processing as well as life sciences and microgravity-related research.

5.4.7 LAND USE AGREEMENTS

KSC has entered into agreements with the U.S. Department of the Interior regarding property management concerning MINWR and CNS.

KSC has an agreement with the FWS of the U.S. Department of the Interior (DOI) to:

- Manage KSC property that is not used specifically for Space Program activities
- Manage KSC property that is not assigned to NPS to manage as part of the CNS

This area, the MINWR, is managed by FWS, which sponsors or directs many wildlife programs, administers the citrus grove leases and apiary permits, and regulates hunting, fishing, and non-consumptive public use activities.

A significant program, relative to NASA operations, is the Fire Management Program administered by USFWS. The Fire Management Program controls vegetative fuel loads at KSC to reduce the potential of wildfires seriously damaging NASA facilities. A secondary management objective of controlled burning is to maintain and perpetuate scrub, slash pine forests and herbaceous wetlands for their habitat and wildlife values.

Prescribed fire management plans are prepared each year prior to burning which identify burn areas, provide site descriptions, burn objectives and burn parameters (Ref. 32). All site specific limitations to burning and smoke management considerations are addressed in the plan.

USFWS and the Brevard Mosquito Control District (BMCD) jointly administer mosquito control at KSC. USFWS maintains and operates approximately 75 mosquito control impoundments at KSC totaling 8,669 ha (21,422 ac). USFWS performs dike maintenance operations and regulates water elevations within the impoundments. BMCD retains the responsibility of monitoring mosquito populations at KSC and the spraying of mosquito larvicides and adulticides.

KSC has an agreement with the DOI for management of a part of CNS by NPS and a part by FWS. NPS administers a 2,693 ha (6,655 ac) area of CNS including a 38 km (24 mi) long beachfront (see Figure 2-3). Management functions include law enforcement, visitor access, and ecological projects. Among the most significant environmental programs initiated by NPS are efforts to stabilize and protect dune vegetation, sea turtle protection, and exotic species eradication programs. NPS has developed a Resource Management Plan, which summarizes the Service's immediate and long-term resource management objectives (Ref. 33).

5.4.8 COASTAL ZONE MANAGEMENT

KSC is not subject to the provisions of the Coastal Zone Management Act of 1977 (CZMA). In rules promulgated to implement CZMA, Federal agencies are to review their activities with regard to direct effects to the coastal zone. Any activities, which directly affect the State's coastal zone, are subject to a determination of consistency with the State's Coastal Management Program (15 CFR 930.30-44).

NASA activities at KSC, which are likely to require consistency determinations include:

- Any project subject to State or Federal dredge and fill permitting review
- Any point or new non-point source discharge to surface waters
- Major industrial expansion or development projects

The review of consistency with CZMP is coordinated through the State, Intergovernmental Coordination and Review Process. The Governors Office (GO) functions as the single point-of-contact for the Intergovernmental Coordination and Review Process and coordinates State agency review and response to consistency determination.

Because any action at KSC, which directly affects the coastal zone, would also be subject to NEPA documentation, consistency review is typically addressed in the NEPA documentation, which is submitted to the GO for review via the Intergovernmental Coordination and Review Process.

5.4.9 FLOODPLAIN AND WETLAND MANAGEMENT

In accordance with EO 11988, "Floodplain Management," and EO 11990, "Protection of Wetlands", KSC has established procedures and planning policies to minimize Federal project and operations impacts on floodplain and wetland resources. Any NASA activity, which significantly impacts floodplains or wetlands, is subject to NEPA documentation requirements. The requirement to prepare an EA insures that all practicable alternatives to the proposed action have been reviewed and that all project impacts have been minimized to the extent possible.

Preparation of an Environmental Assessment (EA) also invites outside agency review and comment on the proposed action.

The 100-year floodplain at KSC has been established by the Federal Emergency Management Agency (FEMA), which has published Flood Insurance Rate Maps (FIRM) for Brevard County. FIRM indicate the 100- and 500-year floodplain and serve as the baseline for floodplain delineation at KSC.

5.4.10 FIRE MANAGEMENT ON KSC/MINWR

5.4.10.1 General. Fire management on KSC is done under an Interagency Agreement with MINWR. The history of fire management done by MINWR can be divided into three phases. The first phase lasted from 1963 to 1980. No comprehensive fire planning, very little prescribed fire, and few wildfire actions characterized it. In 1981, the KSC/MINWR experienced a severe fire season. During this year, almost 6,880 ha (17,000 ac) were burned in wildfires and two Refuge employees were killed. This started the next stage in the development of fire management on the refuge that involved a concerted effort to upgrade the fire program. Extensive training of fire personnel was done and new fire equipment was purchased. Prescribed burning objectives during this time were directed primarily towards the reduction of hazardous fuels. During the last phase, from the early 1990's to the present, efforts were made to change the emphasis of prescribed fire. Instead of a single objective, fuels management, using fire to modify and restore wildlife habitats, became more important.

5.4.10.2 The Early Fire Years. Fire management began slowly on MINWR. Reporting of wildfires was spotty from 1975 until 1981, and the only documentation of prescribed burns was found in Refuge's annual narratives. The refuge's first formal Fire Management Plan was approved in 1979 (Ref. 34). Although simplistic by today's standards for fire management planning, it marks the change from a haphazard approach to fire to a more sophisticated decision-making and planning process. Based on this plan, fire prescriptions for 20 burn units were developed in 1980.

5.4.10.3 The 1980-1981 Fire Season. There were dry conditions in 1980, and these continued into 1981. This led to a severe fire season with 41 wildfires burning a total of 6,770 ha (16,731 ac). More importantly, the dry conditions, heavy fuel loads, less than satisfactory equipment, and lack of training led to two fatalities on June 8, 1981.

5.4.10.4 1982-1992. Beginning in 1982, efforts began in earnest to rectify some of the problems that led up to the catastrophe of 1981. Funds became available for the purchase of new equipment, firefighter positions, and training. A contract was let for a light helicopter with a bucket for suppression work. Prescribed burning objectives during this time period were directed towards reducing the heavy fuel loads on the refuge. Thirty-one Aerial Ignition Units were developed for the refuge, based on existing natural and man-made barriers. They ranged in size from 118.6 to 1,783.1 ha (293 to 4,406 ac) and had a variety of vegetation types in each unit. From 1982 through 1992, there were 113 prescribed burns averaging 539.9 ha (1,334 ac) each. Most of these burns were aerially ignited using a contract helicopter. During this same time

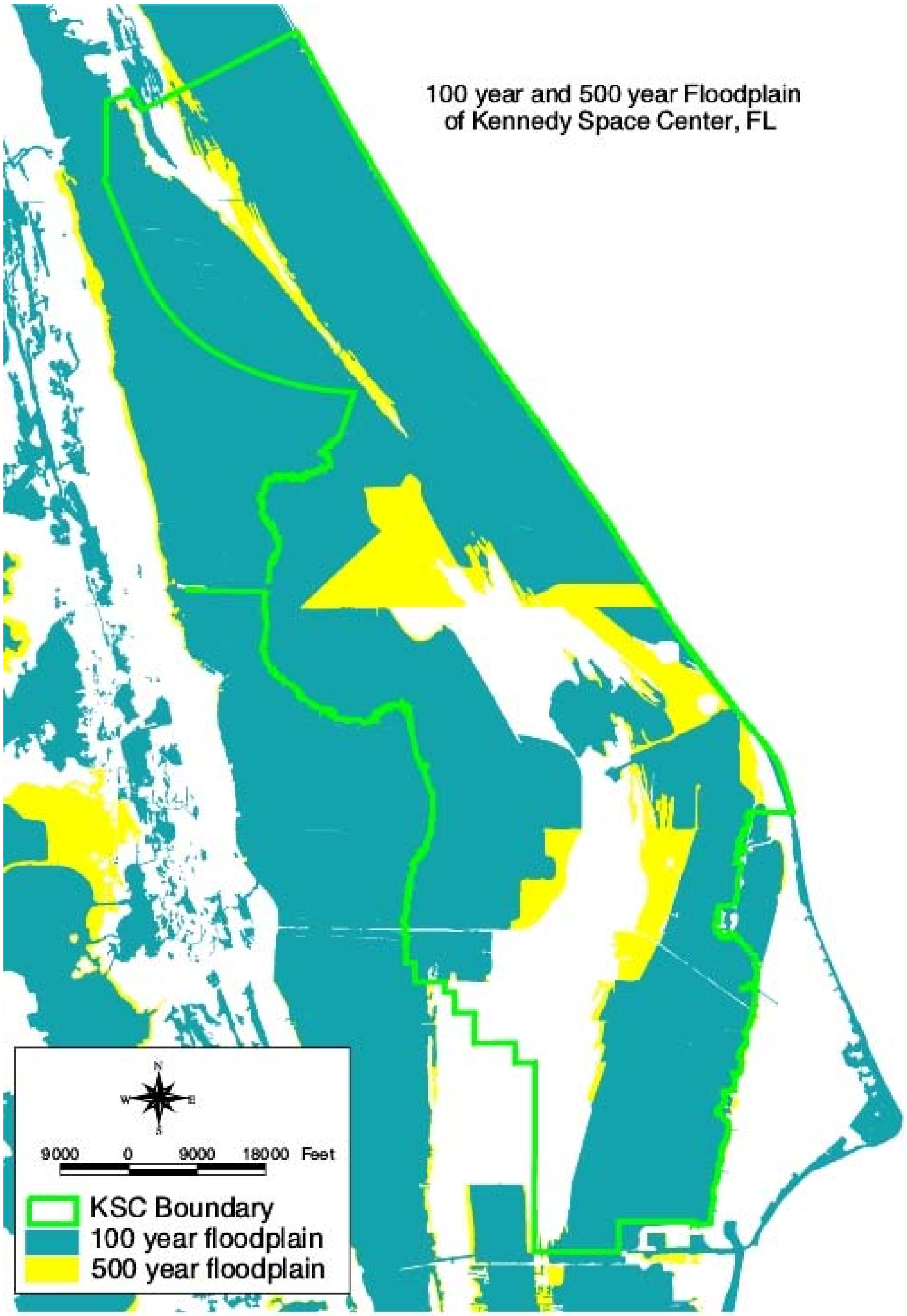

Figure 5-7. 100- and 500-Year Floodplain on Kennedy Space Center.

period, KSC/MINWR had 214 wildfire suppression actions. These fires averaged only 2.7 ha (6.7 ac) in size. The contract helicopter was essential in managing these wildfires.

5.4.10.5 Ecological Burning. About 1990, the emphasis for prescribed burning began to change. Concern for habitat for threatened and endangered species, notably the Florida scrub jay (*Aphelcoma coerulescens coerulescens)*, caused the objectives of burning to move from solely fuels reduction to habitat maintenance and enhancement (Ref. 35). Prescribed burning, along with other vegetation management techniques, was used to improve scrub habitat. Likewise, fire was used along with water management to improve the quality of wetlands. Many of the large burn units in the uplands were subdivided. Smaller burn units reduced the number of different kinds of vegetation in each unit, which gave Fire Managers the ability to tailor burns to meet specific habitat requirements. This also provided additional benefits including reduced smoke management problems. Currently, there are 141 units on KSC/MINWR for prescribed burning (Figure 5-8**)** including impoundments; these range in size from 13.8 to 1,127.9 ha (34 to 2,787 ac).

Between 1993 and 2000, a total of 151 prescribed fires were conducted. The average size was 181.7 ha (449 ac) a significant reduction in area from the prescribed burns in the 1980's. Much of these burns were done to support a joint effort between the refuge and Kennedy Space Center to restore overgrown Florida scrub-jay habitat. Money was provided by KSC for mechanical treatment of scrub. Refuge personnel did the actual treatment and the burning. Many of the scrub jay burns were less than 40.5 ha (100 ac) and were concentrated in the areas that supported the three main jay population centers on the refuge. Larger burns were done in other areas of the refuge to maintain habitat and manage hazardous fuels. Burning continued in the impoundments to enhance habitat for wading birds, shore birds, and migratory waterfowl.

5.5 REFERENCES

1. Jenny, H. 1941. Factors of soil formation. McGraw-Hill. New York.

2. Jenny, H. 1980. The soil resource origin and behavior. Springer-Verlag. New York. 377p.

3. Huckle, H.F., H.D. Dollar, and R.F. Pendleton. 1974. Soil survey of Brevard County, Florida. U.S. Dept. of Agricultural, Soil Conser. Ser., Washington, D.C., USA. 231 p.

4. Baldwin, R., C.L. Burch, R.B. Hinton, H.H. Huckle, P. Nichols, F.C. Watts, and J.A. Wolfe. 1980. Soil survey of Volusia County, Florida. USDA Soil Conservation Service, Washington, D.C. 207 p. and maps.

5. Milliman, J.D. 1972. Atlantic Continental Shelf and Slope of the United States – petrology of the sand fraction of sediments, Northern New Jersey to Southern Florida. U.S. Geological Survey Professional Paper 529-J. Washington, D.C. 40 p. and maps.

6. Schmalzer, P. A., M. A. Hensley, M. Mota, C.R. Hall, and C. A. Dunlevy. 2000. Soil, Groundwater, Surface Water, and Sediments of Kennedy Space Center, Florida: Background Chemical and Physical Characteristics. NASA Technical Memorandum 2000-20853. 595 pp.

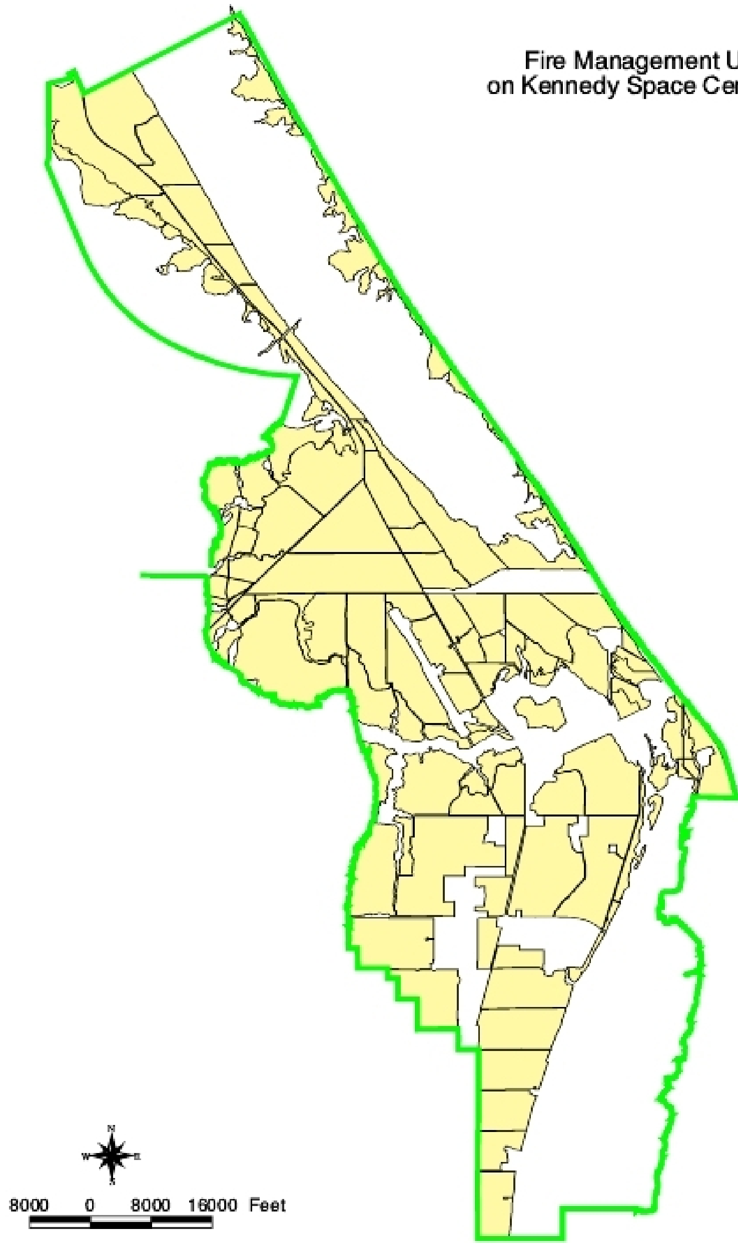

Figure 5-8. Fire Burn Units on MINWR.

7. Schmalzer, P. A., M. A. Hensley, and C. A. Dunlevy. 2001. Background characteristics of soils of Kennedy Space Center, Merritt Island, Florida: selected elements and physical properties. Florida Scientist 64:161-190.

8. Ponnamperuma, F.N. 1972. The chemistry of submerged soils. Advances in Agronomy 24:29-96.

9. Schmalzer, P.A. and C.R. Hinkle. 1987. Effects of fire on composition, biomass and nutrients in oak scrub vegetation on John F. Kennedy Space Center, Florida. NASA Technical Memorandum 100305. John F. Kennedy Space Center, Florida. 146p.

10. Schmalzer, P.A. and C.R. Hinkle. 1992. Species composition and structure of oak-saw palmetto scrub vegetation. Castanea 57:220-251.

11. Schmalzer, P.A. and C.R. Hinkle. 1996. Biomass and nutrients in aboveground vegetation and soils of Florida oak-saw palmetto scrub. Castanea 61:168-193.

12. Randazzo, A.F. 1997. The sedimentary platform of Florida: Mesozoic to Cenozoic. p. 39-56. In: A.F. Randazzo and D.S. Jones (eds.). The Geology of Florida. University Press of Florida. Gainesville.

13. Scott, T.M. 1997. Miocene to Holocene history of Florida. p. 57-68. In: A.F. Randazzo and D.S. Jones (eds.). The Geology of Florida. University Press of Florida. Gainesville.

14. Cooke, C.W. 1945. Geology of Florida. Florida Geological Survey Bulletin 29:1-339.

15. Brown, D.W., W.E. Kenner, J.W. Crooks, and J.B. Foster. 1962. Water resources of Brevard County, Florida. Report of Investigations No. 28. Florida Geological Survey. Tallahassee. 104p.

16. Bowen, D.Q. 1978. Quaternary geology: a stratigraphic framework for multidisciplinary work. Pergamon Press. New York. 221p.

17. Field, M.E. and D.B. Duane. 1974. Geomorphology and sediments of the Inner Continental Shelf, Cape Canaveral, Florida. Technical Memorandum No. 42. U.S. Army Corps of Engineers Coastal Engineering Research Center, Fort Belvoir, Virginia. 88p.

18. Delcourt, P.A. and H.R. Delcourt. 1981. Vegetation maps for eastern North America: 40,000 Yr. B.P. to the present. p.123-165. In: R.C. Romans (ed.). Geobotany II. Plenum Publishing Corporation.

19. Davis, R.A., Jr. 1997. Geology of the Florida coast. p. 155-168. In: A.F. Randazzo and D.S. Jones (eds.). The Geology of Florida. University Press of Florida. Gainesville.

20. Brooks, H.K. 1981. Geologic map of Florida. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Gainesville.

21. Brooks, H.K. 1972. Geology of Cape Canaveral. p. 35-44. In: T.E. Garner (ed.). Space-age geology. Southeastern Geology Society. Tallahassee, Florida.

22. White, W.A. 1958. Some geomorphic features of central peninsular Florida. Geological Bulletin No. 41. Florida Geological Survey. Tallahassee. 92p.

23. White, W.A. 1970. The geomorphology of the Florida peninsula. Geological Bulletin No. 51. Bureau of Geology, Florida Department of Natural Resources. Tallahassee. 164p.

24. Chaki, S. 1974. Study of beach ridges, Cape Canaveral, Florida. Coastal Research Notes 4(2):5-7.

25. Mehta, A.J. and H.K. Brooks. 1973. Mosquito Logoon barrier beach study. Shore and Beach 41(2):26-34.

26. Bader, S.F. and R.W. Parkinson. 1990. Holocene evolution of Indian River Lagoon in Central Brevard County, Florida. Florida Scientist 53:204-215.

27. Clapp, D. 1987. Chapter 1. Overview of physiographic and surface drainage features. p. 1-1-1-27. In: J.S. Steward and J.A. VanArman (eds.). Indian River Lagoon Joint Reconnaissance Report. St. Johns River Water Management District and South Florida Water Management District. Palatka and West Palm Beach, Florida.

28. Edward E. Clark Engineers-Scientists, Inc. 1987. KSC subsurface hydrology and groundwater survey. Volume IV. The areawide groundwater survey program. KSC-DF-3081. Edward E. Clark Engineers-Scientists, Inc., Kennedy Space Center, Florida. Contract No. NAS10-11293.

29. Toth, D. 1987. Chapter 4. Hydrogeology. p. 4-1-4-13. In: J.S. Steward and J.A. VanArman (eds.). Indian River Lagoon Joint Reconnaissance Report. St. Johns River Water Management District and South Florida Water Management District. Palatka and West Palm Beach, Florida.

30. Smith, D.L. and K.M. Lord. 1997. Tectonic evolution and geophysics of the Florida Basement p. 13-26. In: A.F. Randazzo and D.S. Jones (eds.). The Geology of Florida. University Press of Florida. Gainesville.

31. NASA. 1984a. Master Plan. John F. Kennedy Space Center, Florida.

32. U.S. Fish and Wildlife Service. 1986b. Summary of 1985/86 Wildfires and Draft Prescribed Fire Treatments for FY-86. Merritt Island National Wildlife Refuge, Merritt Island, Florida.

33. National Park Service. 1986. Cape Canaveral National Seashore Resources Management Plan. Canaveral National Seashore, Florida.

34. Leenhouts, W.P. 1979. Fire Management Plan Merritt Island National Wildlife Refuge. U.S. Fish and Wildlife Service, Merritt Island National Wildlife Refuge. Titusville, Florida.

35. Adrian, F.W., and R. Farinetti. 1995. Fire Management Plan, Merritt Island National Wildlife Refuge. U.S. Fish and Wildlife Service, Merritt Island National Wildlife Refuge. Titusville, Florida.

SECTION VI

NATURAL RESOURCES

6.1 GENERAL

KSC, which contains within its boundaries the Merritt Island National Wildlife Refuge (MINWR) and most of Canaveral National Seashore (CNS), is located on the northern part of Merritt Island on the east coast of central Florida and consists of approximately 56,700 ha (140,000 ac) of land and lagoon waters. Merritt Island and the adjacent Cape Canaveral form a barrier island complex of Pleistocene and Recent Age (Ref. 1 and 2). The topography is marked by a series of ridges and swales derived from relict dunes deposited as the barrier islands were formed. Erosion has reduced the western side of Merritt Island to a nearly level plain (Ref. 3). Elevation ranges from sea level to about 3 m (10 ft) in the inland areas and to 6 m (20 ft) on the recent dunes. Soils of the area have been derived primarily from deposits of sand and sandy coquina, but vary greatly with landscape position, drainage, and age of parent material (Ref. 4 and 5).

All KSC facilities are located on Merritt Island and Cape Canaveral, both of which are barrier islands. The designated Merritt Island land mass is bordered on the west by the Indian River, on the southeast by the Banana River, and on the north by Mosquito Lagoon. This land mass has a maximum east-west width of about 11.3 km (7 mi) and a north-south length of about 50 km (31 mi), of which KSC occupies about 19.3 km (12 mi). Merritt Island is composed of relict beach ridges on the eastern side of the Island and thus the land surface is undulating. The troughs are near sea level and the ridges rise to a maximum of about 3 m (10 ft) above sea level. The land surface the western side of Merritt Island is near level with an elevation of 1.2 m (4 ft) above sea level near the center of the Island to about 0.2 m (0.5 ft) above sea level at the Indian River shoreline. This plain is a result of erosional forces smoothing out the beach ridges as the island's deposition progressed from west to east. Surface deposits on Merritt Island are of Pleistocene and Recent Ages consisting primarily of sand and sandy coquina (a course grained, porous limestone composed principally of mollusk shell and coral fragments). Differences in landscape position, drainage, and age have produced a wide variety of soils (Ref. 5).

The surface drainage pattern of Merritt Island is multibasinal. Surface drainage is typically internal, being trapped in the ponds, lakes, sloughs, burrows and man-made canals on the Island. External drainage is conducted primarily by man-made drainage systems (i.e., Industrial Area to the Banana River via Buck Creek) and by way of grove management pumps to the Indian River. These drainage systems are most prevalent in the developed areas and surrounding uplands adjacent to the bordering water bodies previously mentioned.

Cape Canaveral is a barrier island about 7.2 km (4.5 mi) wide. The land surface of Cape Canaveral is typical coastal strand with a shoreline elevation at sea level and dune peaks up to about 6 m (20 ft.) above sea level. Drainage of Cape Canaveral is typically internal with any external drainage discharging into the Banana River and the Atlantic Ocean.

6.2. REGULATORY OVERVIEW

6.2.1 FEDERAL PROGRAMS AND POLICIES ON UPLANDS

The U.S. Fish and Wildlife Service (USFWS) has been given the responsibility of protecting wildlife habitat. There are no direct references to protecting uplands in the Endangered Species Act of 1973, although many species on this list do require uplands habitat. The regulation of uplands results from the regulation of habitat for protected animals and plants.

6.2.2 STATE REGULATION OF UPLANDS

The State Comprehensive Plan protects and acquires unique natural habitats and ecological systems such as uplands. Local comprehensive plans must be consistent with the State Comprehensive Plan. These comprehensive plans provide an outline for regulating habitats, while land development regulations are the instruments, which require upland habitat preservation. KSC is excluded from coverage under these rules.

6.2.3 FEDERAL PROGRAMS AND POLICIES ON WETLANDS

Most wetlands are considered waters of the U.S. and are under the jurisdiction of the Clean Water Act (CWA). A number of Federal agencies administer programs that can potentially affect wetlands and their likelihood for utilization. Six of these are briefly discussed below.

The Army Corps of Engineers (COE) administers the Section 404 - Dredge and Fill Permit Program - of the CWA. The Federal dredge and fill regulations are codified in 33 CFR 290.320. The program may be delegated to the states. Any action involving discharges of dredged or fill material in Waters of the U.S., including wetlands, requires a permit under Section 404. COE has issued nationwide permits, which cover discharges of dredged or fill material into isolated wetlands or wetlands above the headwaters subject to certain conditions, size limitations, and reporting requirements (Ref. 6).

The Florida Department of Environmental Protection (FDEP) and COE have developed a joint application form for dredge and fill (wetland resource) permits. Copies of applications submitted to FDEP are automatically forwarded to COE. See Section 4 for further information on wetland resource permitting.

FDEP and the Water Management Districts have developed a streamlined permit, which was adopted on July 1, 1994. The Environmental Resource Permit (ERP) will repeal DEP dredge and fill statute in chapter 403, F.S. and incorporate it into Part IV Chapter 373, F.S., Management and Storage of Surface Waters. This will combine DEP and water management districts wetland permitting programs into one process.

USFWS has been delegated the responsibility of protecting wetlands and wildlife habitat. USFWS actually seeks to preserve or create natural habitat and, under some circumstances, has supported wetlands wastewater discharges to achieve these goals (Ref. 6).

The U.S. Department of Interior (USDOI) has been given responsibility to identify threatened and endangered species through the Endangered Species Act. A number of species protected by the Endangered Species Act are dependent on wetlands during some part of their life. The Act emphasizes the need to preserve critical habitats upon which protected species depend (Ref. 6).

Executive Order (EO) 11990 was issued in May 1977, to emphasize the need for wetlands protection. Federal agencies were required to develop policies for enhancing wetlands protection and minimizing wetlands impacts. The EO suggested that Federal assistance or financial support be withheld from any activity not in keeping with its goals. EO 11988 was issued to curtail developmental activities in floodplains. It is similar to the wetlands EO in its goals and means for obtaining those goals (Ref. 6). The Orders are codified for NASA in 14 CFR 12165.2. They are also incorporated into the NASA Management Directives System.

The Environmental Protection Agency (EPA) policy to protect the Nation's wetlands issued in 1973 recognizes the inherent values of wetlands. The policy has four major elements:

(1) To evaluate a proposal's potential to degrade wetlands and preserve and protect them in decision processes.

(2) To minimize alterations and prevent violation of applicable water quality standards.

(3) In comply with NEPA, withhold Construction Grants funds for municipal wastewater treatment facilities except where no other alternative of lesser environmental damage is found to be feasible.

(4) To advise applicants, who install waste treatment facilities under a Federal grant program or Federal permit, to select the most environmentally protective alternatives.

6.2.4 ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

The St. Johns River Water Management District (SJRWMD) maintains a regulatory and planning program, which focuses on water quantity as well as water quality. SJRWMD considers wetlands as hydrologically sensitive areas and exerts regulatory jurisdiction over dredge and fill activities within wetlands. All SJRWMD permit activities are delegated by FDEP and are related to stormwater permit authority. As stated previously, FDEP and SJRWMD are in the process of developing a new ERP proposed under Chapter 40C, 400 Florida Administrative Code (F.A.C.), which combines FDEP dredge and fill permitting with SJRWMD management and storage of surface waters.

Briefly, SJRWMD uses three indices to identify wetlands; 1) reliable hydrologic records, 2) vegetative index, and 3) soils index. The reliable hydrologic records, if available, must indicate that the area is inundated or saturated for 30 or more consecutive days per average year. If such hydrologic records, which are the best indicator of inundation, are not available, the areas dominated by the vegetation listed in SJRWMD Management and Storage of Surface Waters Applicant's Handbook or the presence of the identified soils for Brevard County will be used to identify wetland areas. In situations where two wetland indicators are in conflict, a SJRWMD representative will make the final determination. Generally, satisfying FDEP requirements will also fulfill requirements of SJRWMD.

6.2.5 STATE REGULATIONS OF WETLANDS

FDEP has the authority to regulate dredge and fill activities in those wetlands, which are subject to their jurisdiction. To distinguish between upland areas and wetland waters of the State, FDEP developed a vegetation index based upon the dominance of certain wetland species codified in Chapter 17-301.400, F.A.C. FDEP jurisdiction can also be determined (or further substantiated) by establishing that the project property is 1) inundated for more than 30 consecutive days per year on an average annual basis or 2) within the elevation of the one-in-ten year flood event. There can be no evidence of a hydrologic connection between the wetland in question and surface water.

Non-jurisdictional wetlands are those, which are entirely confined on privately-owned lands and have no connections to downstream waters or groundwater. These wetlands, however, may still be regulated by Federal agencies (Ref. 6).

The Warren S. Henderson Wetlands Protection Act of 1984 was placed in effect in October 1984, becoming the State's first law directed specifically at protecting and preserving Florida's remaining wetlands. The new Chapter 40C-400 F.A.C. placed into effect on July 1, 1994, consolidates FDEP and SJRWMD dredge and fill activities with the management and storage of surface waters. This new regulation will repeal the Henderson Wetlands Protection Act of 1994.

6.3 VEGETATION: UPLAND AND WETLAND HABITATS

The 1995 vegetation and land cover map prepared for the St. John’s River Water Management District was used as the basis for the vegetation and land cover map presented here (Figure 6-1, Table 6-1). The original map used the Florida Land Use Cover and Forms Classification System (FLUCCS, Ref. 7). The classification was simplified for presentation here, and some corrections to the base coverage were made. However, the extent of corrections was limited and no groundtruthing or accuracy assessment of this map has been conducted.

6.3.1 UPLAND VEGETATION

These types are natural communities occurring on sites that are not flooded for extended periods. Minor areas of wetlands may be included in these mapping units.

6.3.1.1 <u>Scrub</u>. Florida scrub is shrub vegetation with scrub oaks (*Quercus geminata, Q. myrtifolia, Q. chapmanii*), saw palmetto (*Serenoa repens*), and ericaceous shrubs (e.g., *Lyonia* spp.) dominant. The best drained of these were mapped as xeric oak in the FLUCCS codes. The map unit here includes scrubby flatwoods, with an open slash pine (*Pinus elliottii*) canopy and minor areas of sand pine (*Pinus clausa*) scrub. Also included are areas mapped as shrub and

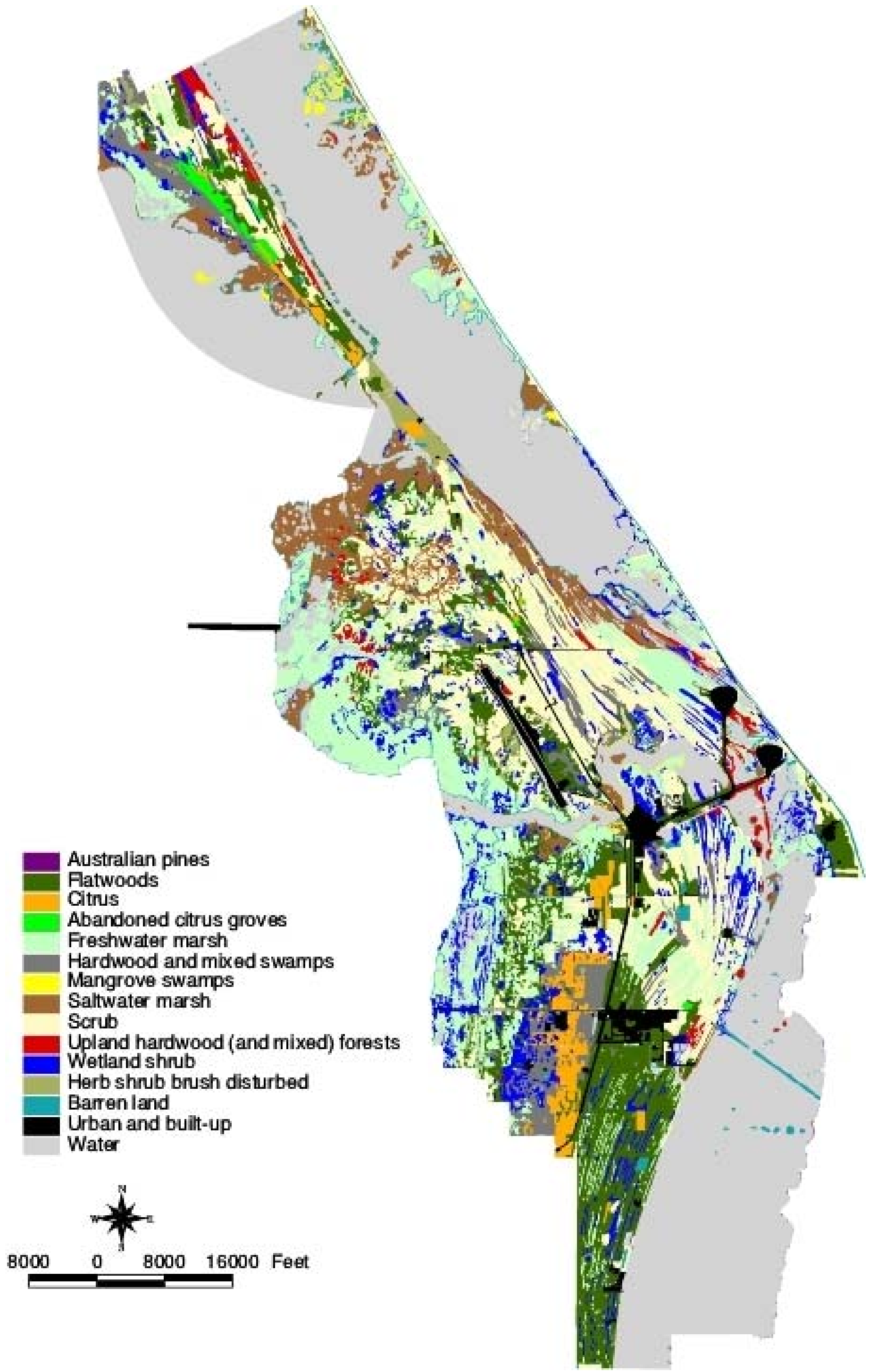

Figure 6-1. Vegetation Types on Kennedy Space Center.

Table 6-1. Land Cover Classes on Kennedy Space Center.

Land Cover Class	Area (ac)	Area (ha)
Upland Vegetation		
Scrub	18301.4	7406.3
Flatwoods	15183.4	6144.5
Hardwood and Mixed Forest	1559.0	630.9
Wetland Vegetation		
Freshwater Marsh	16488.4	6672.6
Hardwood and Mixed Swamps	5172.1	2093.1
Wetland Shrubs	6622.6	2680.1
Saltwater Marsh	7448.2	3014.2
Mangrove Swamp	451.7	182.8
Anthropogenic		
Australian Pine	32.9	13.3
Citrus	2187.6	885.3
Abandoned Citrus	512.3	207.3
Herb Shrub Brush Disturbed	925.1	374.4
Barren Land	2381.7	963.8
Urban and Developed	3800.3	1537.9
Water	54228.1	21945.4

Derived from 1995 St. John's River Water Management District map with modifications.

brush land, where saw palmetto, wax myrtle (*Myrica cereifera*), and fetterbush (*Lyonia lucida*) are dominant, but some scrub oaks may occur.

6.3.1.2 Flatwoods. Pine flatwoods on KSC have slash pine or less commonly pond pine (*Pinus serotina*) as canopy species. The understory includes saw palmetto, wax myrtle, fetterbush, and other shrubs and herbs. Some scrubby flatwoods may be included in this map unit. Pine densities were low in native flatwoods. In disturbed sites, or where fire has been suppressed, pines often become dense.

6.3.1.3 Hardwood and Mixed Forest. These are closed canopy forests primarily of hardwoods on upland sites. They may include native hammocks or xeric hammocks that have developed from long periods of fire exclusion on scrub sites (Ref. 8).

6.3.2 WETLAND VEGETATION

These types are natural communities that occur on sites that are flooded for short-to-long periods in most years. Minor areas of uplands may be included in these mapping units.

6.3.2.1 Freshwater Marsh. A variety of freshwater marshes occur in swales of the dune-swale topography of Merritt Island and the upper section of coastal wetlands. Specific types include sand cordgrass (*Spartina bakeri*), sawgrass (*Cladium jamaicense*), maidencane (*Panicum hemitomon*), and others. Wet prairies, cabbage palm savannas, and emergent aquatic vegetation are also included in this map class. With impoundment, many former saltwater marshes changed to freshwater systems. Many marshes have been reconnected to the lagoons since 1995, but any subsequent vegetation changes are not reflected here.

6.3.2.2 Hardwood and Mixed Swamps. These are forests primarily of wetland hardwoods including red maple (*Acer rubrum*), elm (*Ulmus americana*), laurel oak (*Quercus laurifolia*), cabbage palm (*Sabal palmetto*), and other taxa. Some mesic hammocks of live oak (*Quercus virginiana*) and cabbage palm may be included, since these often intergrade in complex pattens.

6.3.2.3 Wetland Shrubs. This map unit includes willow (*Salix caroliniana*) swamps and wetland areas occupied by wax myrtle and saltbush (*Baccharis* spp.). The later type is common in impounded saltwater wetlands.

6.3.2.4 Saltwater Marsh. Saltwater marshes occur in areas bordering the lagoon systems. Sand cordgrass, black rush (*Juncus roemerianus*), saltgrass - seashore paspalum (*Distichlis spicata - Paspalum vaginatum*), and mixed halophyte (*Batis maritima, Salicornia* spp.) type occur. These marshes have been influenced by impoundment and hydrologic alternation.

6.3.2.5 Mangrove Swamps. Mangroves occur in natural and impounded saline areas. Black mangrove (*Avicennia germinans*) and white mangrove (*Laguncularia racemosa*) are the most common species on KSC with some red mangrove (*Rhizophora mangle*) also present. Buttonwood (*Conocarpus erectus*) often occurs in transitional areas.

6.3.3 ANTHROPOGENIC

These are sites affected by development, agriculture, or other human alternation.

6.3.3.1 Australian Pine. Groves or windbreaks of one or more species of *Casuarina* persist from planting around groves or old home sites.

6.3.3.2 Citrus. Some citrus groves remain active on KSC. Many have been abandoned since 1995; therefore, the area mapped here is an overestimate of current conditions.

6.3.3.3 Abandoned Citrus Groves. These are former citrus groves where cultivation has been abandoned. Citrus trees may still persist, but many are invaded by exotic and nuisance species (e.g., Brazilian pepper [*Schinus terebinthifolius*] and guineagrass [*Panicum maximum*]).

6.3.3.4 Herb Shrub Brush Disturbed. This class includes areas previously cleared or in agriculture and revegetated by exotic shrubs, such as Brazilian pepper or mixtures of exotic and native species. Some areas of disturbed or degraded scrub vegetation may also be included.

6.3.3.5 Barren Land. This class includes spoil areas, bare ground, and other cleared, disturbed, or non-vegetated areas.

6.3.3.6 Urban and Developed. This class includes facilities, roads, railroads, runways, recreational areas, and other similar types.

6.3.4 WATER

This class includes the lagoon systems within KSC's boundaries, open water within marshes, and impoundments, streams, ponds, and other open water.

6.4 WETLANDS AND IMPOUNDMENTS

Wetland habitats provide a vast array of ecosystem functions and serve as links and buffers between terrestrial and aquatic ecosystems where sediment and nutrients from uplands are trapped and transformed into plant biomass. They provide habitat for numerous animals (especially fish and birds), thus helping to maintain biodiversity. They are a source of particulate and dissolved organic materials for the adjacent lagoon water column, supporting estuarine fisheries production. They also moderate storm/flood damage to upland areas. These functions are dependent on local hydrology and hydrologic links to the estuary.

In the IRL, the vast majority (over 75 percent) of the historic wetlands have been impounded for mosquito control and isolated from the estuary since the late 1950s and 1960s. Approximately 28,000 (80 percent) of the 14,164 ha (35,000 ac) of IRL impounded estuarine wetlands within SJRWMD are located within the MINWR and are a part of KSC (see Figure 6-2). Under an agreement with DOI, the lands within KSC that are not directly used by the Space Program are managed by the USFWS.

6.4.1 WHY MARSHES WERE IMPOUNDED

Salt marsh mosquitoes (*Aedes spp*) need moist exposed substrate for oviposition sites and then flooding to produce a brood. The intertidal shorelines, tidal wetlands and marshes along the IRLS (including the Banana River and Mosquito Lagoon) are ideal for mosquito production. These conditions are present throughout the year with peak conditions occurring during the summer, wet season, and May-September (Ref. 9, 10, and 11). To control the salt marsh mosquitoes, managers can use chemical agents (pesticides) or a biological control to interrupt part of the mosquito's life cycle. The portion of the life cycle easiest to interrupt is the oviposition site. This can be accomplished by either drying out and keeping dry the exposed moist substrate needed for oviposition or by keeping this substrate flooded.

In the 1950-60's, mosquito control managers set about to control mosquitoes by interrupting the oviposition portion of the life cycle. To achieve this goal, the wetlands and exposed intertidal areas along the coastal and estuarine shorelines, were impounded by building earthen dikes around these areas and then flooding these areas. This worked well for controlling mosquitoes (Ref. 9, 10, and 11); however, it removed not only tidal access but any type of water connection between the estuary and the wetlands. These habitats that were once accessible to fish and macro-crustaceans are now removed from the ecosystem (Ref. 12, 13, 14, 15, 16, and 17).

6.5 SEAGRASS HABITAT

Much public and scientific attention has focused on seagrasses due to the documentation of human influence on the worldwide decline of seagrass and the increased awareness of the

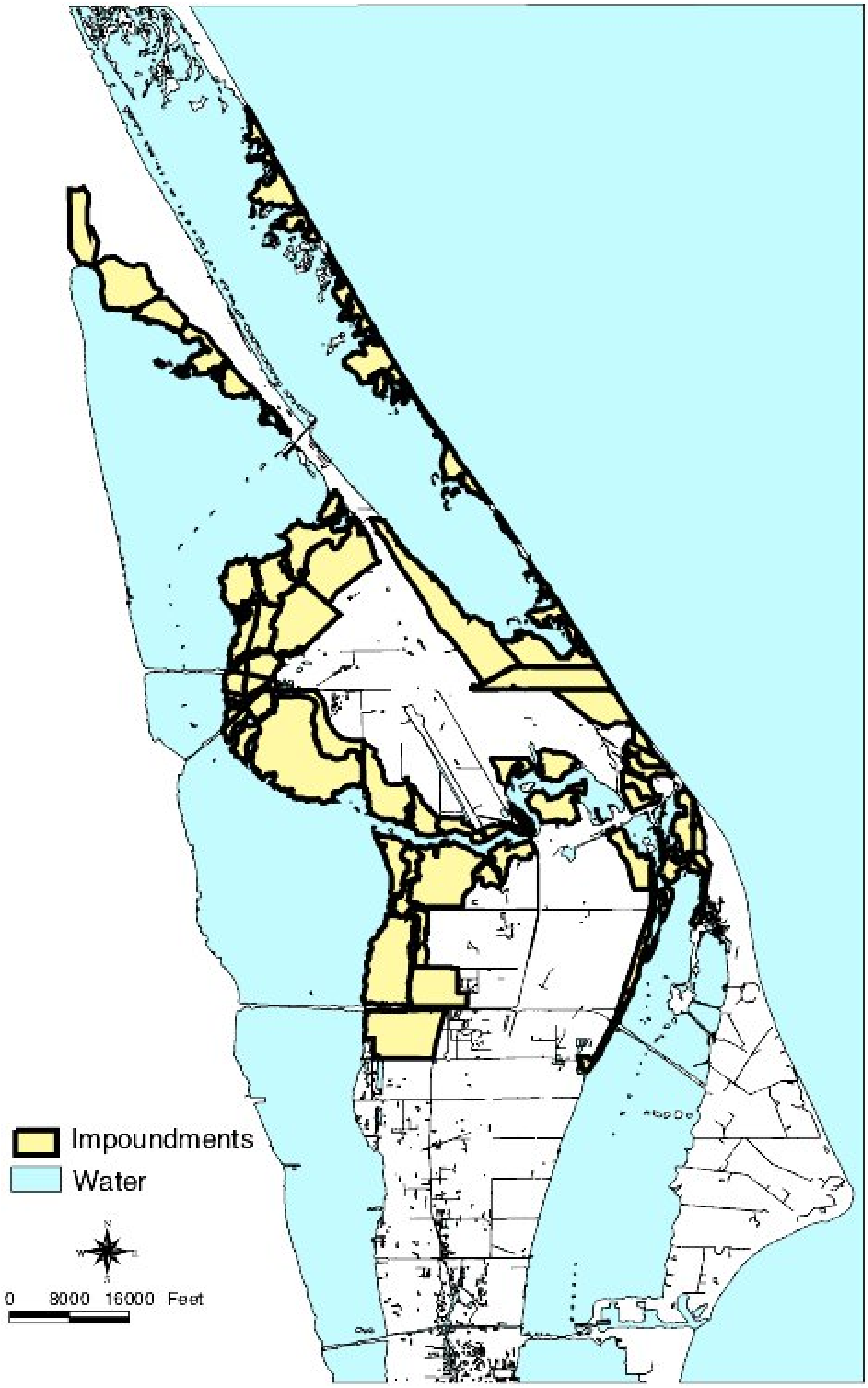

Figure 6-2. Mosquito Control Impoundments on the Kennedy Space Center.

importance of seagrass as habitat (Ref. 18 and 19). In addition, numerous recreational and commercial fish found offshore spawn and grow in seagrass beds. Seagrasses and submerged aquatic vegetation (SAV) are currently considered the ecological foundation of the IRLS (Ref. 20).

The causes of decline of SAV in various estuaries have been attributed to increases in the runoff associated with agricultural herbicides, suspended nutrients, sediments, and toxic discharges. Research in various locations has determined that decreasing light intensity (analogous to decreasing water clarity) causes a major effect on production, biomass, and morphology (Ref. 20and 21).

Seagrass beds are found in varying sizes along the IRL shoreline. There are seven species with distributions that vary along the north-south axis of the IRL. All seven species occur in the southern third (Ref. 22). Three of the seven (*Thalassia testudinum, Halophila johnsonii*, and *Halophila dicipiens*) are not found in the northern IRL, where *Halodule wrightii*, *Syringodium filiforme*, *Ruppia. maritima*, and *Halophila engelmannii* do occur. Primary production and habitat/species interactions research has been predominantly conducted in the southern part of the Lagoon (Ref. 22, 23, and 24).

The seagrass beds in Mosquito Lagoon provide direct forage for marine turtles (*Chelonia mydas*) and manatees (*Trichechus manatus*). The Banana River portion of the study area is remarkably "devoid" of marine turtles, but provides habitat for large numbers of manatees (Ref. 25 and 26). Several studies have begun to explore the relationships between this large herbivore and its seagrass forage (Ref. 27, 28, 29, 30, and 31).

The Biomedical Office began funding baseline ecological studies in the 1970's in preparation for the Space Transportation System (Space Shuttle) operations. In 1983, Brevard County and KSC began a cooperative project to set up transects in various seagrass beds, that would provide ground truth sites to coordinate with aerial photography. The objective was to create a baseline dataset from each transect to provide descriptive information regarding species composition, percent cover, and frequency of occurrence. Collected over a long term, these data provide time series information to allow for assessment of trends in seagrasses in northern Indian River Lagoon. These data provide a "barometer" at the local level, allowing for detection of anthropogenic versus natural changes, and could be used in regional comparisons.

A long-term study of seagrass beds in lagoonal waters of KSC was conducted from 1983-96, and included 8,150 samples collected along 37 shallow water transects. Species composition and percent cover were determined at 5-m intervals along the transects using a canopy-coverage technique originally developed for terrestrial systems (Ref. 32).

Four seagrass species were found as well as one attached algae. The overall frequency of occurrence for each species indicated the following dominance: *Halodule wrightii* (71.9 percent), *Ruppia maritima* (23.7 percent), *Syringodium filiforme* (9.4 percent), *Halophila engelmannii* (2.3 percent) and *Caulerpa prolifera* (5.4 percent). *H. wrightii* and *R. maritima* were represented on most transects. *S. filiforme* was never encountered on 14 of 37 transects, and when it occurred, the most frequently recorded percent coverage was <5. Temporal trends in percent cover for *H.*

wrightii indicates a significant long-term decline. *R. maritima* maintained an average occurrence of 26 percent and cover of 6 percent from 1983-89. These averages dropped to 11 percent occurrence and 1.2 percent cover for 1990-94. A marked increase occurred in 1995-96, when occurrence was 49 percent and percent cover was 19. The increase in *R. maritima* and decline in *S. filiforme* and *H. wrightii* appear to be linked to recent declines in salinity. An increase in the number of bare plots was also observed over the study. *C. prolifera* was observed in remarkably high coverages from 1986-1987, but rapidly declined by 1989. These data provide a benchmark that will be useful to researchers and managers in comparing trends observed elsewhere in the Lagoon and determining if these are site specific or regional trends (Ref. 33).

6.6 WILDLIFE

6.6.1 GENERAL

By virtue of its geologic history and physical location, KSC is comprised of many diverse plant communities. The close proximity of uplands and wetlands, and the mixing of temperate and subtropical flora provide habitat for a large number of wildlife species. MINWR is home to more Federally protected species than any other National Wildlife Refuge in the continental U.S. NASA, USFWS, and the National Park Service (NPS) share the conservation and management responsibilities for these natural resources.

6.6.2 FISH

The IRLS is quite prolific with a variety of species of fish. This system has been the subject of extensive studies concerning the taxonomy, abundance, habitat preservation, and protection (Ref. 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, and 44). The Lagoon is a biogeographic transition zone, rich in habitats and species, with the highest species diversity of any estuary in North America (Ref. 56). Nearly 150 fish species have been identified in the Lagoon surrounding KSC (Ref. 56). Species diversity is generally high near inlets and toward the south end of the Lagoon. It is lower near cities, where nutrient input, sedimentation, and turbidity are high and where large areas of mangroves and seagrasses have been lost. For biological communities and fisheries, seagrass and mangrove habitats are extremely important (Ref. 45). Much of the habitat loss has occurred as the result of shoreline development, navigational improvements, and marsh management practices. Relative to the southern part, KSC supports fewer tropical, oceanic, and freshwater species (Ref. 46). Latitudinal temperature gradient, the absence of hard bottom and reef-like habitats, and reduced oceanic inlet influences are suspected factors in limiting species diversity in the northern part (Ref. 37). The absence of permanent fresh water habitats, prior to the presence of man on Merritt Island, is believed responsible for a limited fresh water fish fauna (Ref. 37). It is been believed that man introduced fresh water fish species on Merritt Island (Ref. 47).

KSC has over 25 species of fish found in the wetlands and impounded wetlands (Ref. 16, 17, and 37). Resident fish in the impounded wetlands dominates fish fauna. Resident fish are fish that spend their entire life cycle within the wetland or impounded wetland area. These species are usually well adapted physiologically to handle the wide variation in environmental conditions, such as, extremes in temperature, salinity and dissolved oxygen. These species can occur in other habitats and commonly do. These species include sailfin molly (*Poecilia latipinna*), eastern mosquitofish (*Gambusia holbrooki*), and sheepshead minnow (*Cyprinodon variegatus*).

Transient fish are species that utilize the marsh habitat during a portion of their life cycle, usually the early stages. These fish may use this area for a source of forage or a refuge from predators. Transient fish are not as well adapted physiologically to handle the harsh or extreme conditions that exist in the wetlands (Ref. 47). Examples of transient fish include striped mullet (*Mugil cephalus*), ladyfish (*Elops saurus*), and common snook (*Centropomus undecimalis*).

Due to the shallow nature of the inshore water bodies, fish kills are not uncommon. Abrupt drops in temperature during the winter months can lead to mortality in some of the fish species (e.g., snook). The more typical cause of fish kills stems from low levels of dissolved oxygen found during the summer months. A summary of fish species, their general salinity and habitat requirements, and relative abundance is provided in Appendix B.

6.6.3 AMPHIBIANS AND REPTILES

Sixty-nine species of amphibians and reptiles, collectively called "herps," have been documented as occurring on KSC (Table 6-2; Ref. 48). Herpetological research on KSC began in the mid-1970s, as part of the environmental monitoring associated with the Space Shuttle Program (Ref. 50). Efforts were focused on marine turtles, diamondback terrapins, and general herp presence/absence surveys. During the 1980s and early 1990s, most herpetological work was species-specific for gopher tortoises and eastern indigo snakes. In 1992, a long-term herpetological monitoring program was established. The objectives of the program are to continue adding to the database of herp knowledge on KSC, to allow comparisons of herp populations between the 1970s and present and to concentrate on specific herp-related issues as they arise.

Several discoveries came to light since the long-term monitoring program began in 1992. Fourteen species have been added to the KSC herp list (Table 6-2). Five of these were added, because of different trapping techniques that were used in the 1990s and not in the 1970s. Two species occur in very low abundance and might not have been documented in the 1970s, merely, because they were never found. Three species are introduced as exotics. It is not clear why the remaining four species were not documented in the earlier studies. One species, the eastern hognose snake, was seen in the 1970s and has not been seen since. Only one specimen was found and was possibly a human-released animal that does not naturally occur on KSC (Ref. 48).

Two species have experienced population declines since the 1970s. A survey technique of road cruising, the same exact route during both sampling periods, found a significant difference in the numbers of cottonmouths between the 1970s and the current studies. One supposition as to the reason behind this decline is the decrease in freshwater habitats from the reconnection of impoundments to the brackish water estuary. Diamondback terrapin populations have also declined. Areas where they were once abundant no longer support large populations. Several theories have been forwarded to explain the decline: incidental deaths in crab traps, too much predation pressure from an increased raccoon population, road mortality, and loss of food resources due to increased water turbidity from dredging ship channels (Ref. 48).

Table 6-2. Amphibians, Reptiles, and Mammals of KSC.

Amphibians		
Salamanders		
two-toed amphiuma	*Amphiuma means*	rarely seen
red-spotted newt	*Notophthalmus viridescens*	common, but rarely seen
lesser siren	*Siren intermedia*	very common, but rarely seen
greater siren	*Siren lacertian*	very common, but rarely seen
Frogs		
oak toad	*Bufo quercicus*	occasionally seen, commonly heard
southern toad	*Bufo terrestris*	commonly seen and heard
cricket frog	*Acris gryllus*	rarely seen, commonly heard
green tree frog	*Hyla cinerea*	commonly seen and heard
pinewoods tree frog	*Hyla femoralis*	occasionally heard at night, rarely seen
barking tree frog	*Hyla gratiosa*	occasionally heard at night, rarely seen
squirrel tree frog	*Hyla squirella*	commonly seen and heard
chorus frog	*Pseudacris nigrita*	rarely seen, commonly heard
little grass frog	*Pseudacris ocularis*	rarely seen, occasionally heard
greenhouse frog (E)	*Eleutherodactylus planirostris*	occasionally seen
narrow-mouthed toad	*Gastrophryne carolinensis*	occasionally seen, commonly heard
eastern spadefoot toad	*Scaphiopus holbrookii*	occasionally seen and heard
gopher frog	*Rana capito*	rarely seen or heard
pig frog	*Rana grylio*	rarely seen, commonly heard
southern leopard frog	*Rana utricularia*	commonly seen and heard
Reptiles		
American alligator	*Alligator mississippiensis*	commonly seen
Turtles		
loggerhead	*Caretta caretta*	commonly seen while nesting
Atlantic green turtle	*Chelonia mydas*	occasionally seen while nesting
snapping turtle	*Chelydra serpentina*	occasionally seen
leatherback sea turtle	*Dermochelys coriacea*	rarely seen
chicken turtle	*Deirochelys reticularia*	rarely seen
diamondback terrapin	*Malaclemys terrapin*	rarely seen
Florida cooter	*Pseudemys peninsularis*	commonly seen
box turtle	*Terrapene carolina*	occasionally seen
striped mud turtle	*Kinosternon baurii*	occasionally seen
common mud turtle	*Kinosternon subrubrum*	occasionally seen
common musk turtle	*Sternotherus odoratus*	occasionally seen
gopher tortoise	*Gopherus polyphemus*	commonly seen
Florida softshell turtle	*Apalone ferox*	commonly seen
Lizards		
slender glass lizard	*Ophisaurus attenuatus*	rarely seen
island glass lizard	*Ophisaurus compressus*	rarely seen
eastern glass lizard	Ophisaurus ventralis	occasionally seen
Indo-Pacific gecko (E)	*Hemidactylus garnotii*	rarely seen
Mediterranean gecko (E)	*Hemidactylus turcicus*	rarely seen
green anole	*Anolis carolinensis*	commonly seen
brown anole (E)	*Anolis sagrei*	commonly seen
mole skink	*Eumeces egregious*	rarely seen
southeastern five-lined skink	*Eumeces inexpectatus*	commonly seen
ground skink	*Scincella lateralis*	occasionally seen
six-lined racerunner	*Cnemidophorus sexlineatus*	commonly seen
Snakes		
scarlet snake	*Cemophora coccinea*	rarely seen

Reptiles (continued)		
black racer	*Coluber constrictor*	commonly seen
ring-necked snake	*Diadophis punctatus*	rarely seen
indigo snake	*Drymarchon corais*	occasionally seen
corn snake	*Elaphe guttata*	occasionally seen
yellow rat snake	*Elaphe obsolete*	occasionally seen
mud snake	*Farancia abacura*	rarely seen
eastern hog-nosed snake	*Heterodon platirhinos*	rarely seen
common kingsnake	*Lampropeltis getula*	rarely seen
scarlet kingsnake	*Lampropeltis triangulum*	rarely seen
coachwhip	*Masticophis flagellum*	occasionally seen
Atlantic saltmarsh snake	*Nerodia clarkia*	rarely seen
banded water snake	*Nerodia fasciata*	commonly seen
green water snake	*Nerodia floridana*	occasionally seen
rough green snake	*Opheodrys aestivus*	occasionally seen
pine snake	*Pituophis melanoleucus*	rarely seen
striped crayfish snake	*Regina alleni*	common, but rarely seen
pine woods snake	*Rhadinaea flavilata*	rarely seen
black swamp snake	*Seminatrix pygaea*	common, but rarely seen
brown snake	*Storeria dekayi*	rarely seen
coastal dunes crowned snake	*Tantilla relicta*	rarely seen
ribbon snake	*Thamnophis sauritus*	commonly seen
garter snake	*Thamnophis sirtalis*	commonly seen
Coral snake (V)	*Micrurus fulvius*	rarely seen
cottonmouth (V)	*Agkistrodon picivorus*	rarely seen
diamondback rattlesnake (V)	*Crotalus adamanteus*	occasionally seen
pygmy rattlesnake (V)	*Sistrurus miliarius*	rarely seen
Mammals		
Virginia opossum	*Didelphis virginiana*	commonly seen
least shrew	*Cryptotis parva*	rarely seen
eastern mole	*Scalopus aquaticus*	rarely seen
southeastern bat	*Myotis austroriparius*	occasionally seen
Brazilian free-tailed bat	*Tadarida brasiliensis*	occasionally seen
nine-banded armadillo (E)	*Dasypus novemcinctus*	commonly seen
eastern cottontail	*Sylvilagus floridanus*	commonly seen
marsh rabbit	*Sylvilagus palustris*	occasionally seen
gray squirrel	*Sciurus carolinensis*	rarely seen
hispid cotton rat	*Sigmodon hispidus*	occasionally seen
marsh rice rat	*Oryzomys palustris*	rarely seen
Florida mouse	*Podomys floridanus*	rarely seen
southeastern beach mouse	*Peromyscus polionotus*	rarely seen
cotton mouse	*Peromyscus gossypinus*	rarely seen
golden mouse	*Ochrotomys nuttalli*	rarely seen
round-tailed muskrat	*Neofiber alleni*	rarely seen
black rat (E)	*Rattus rattus*	rarely seen
raccoon	*Procyon lotor*	commonly seen
long-tailed weasel	*Mustela frenata*	rarely seen
eastern spotted skunk	*Spilogale putorius*	occasionally seen
river otter	*Lutra canadensis*	occasionally seen
gray fox	*Urocyon cinereoargenteus*	rarely seen
red fox (E)	*Vulpes vulpes*	rarely seen
coyote (E)	*Canis latrans*	rarely seen
bobcat	*Felis rufus*	occasionally seen

Mammals (continued)		
bottle-nosed dolphin	*Tursiops truncates*	commonly seen
manatee	*Trichechus manatus*	commonly seen
wild hog (E)	*Sus scrofa*	commonly seen
white-tailed deer	*Odocoileus virginianus*	rarely seen
E = Exotic V = Venomous		

The ocean beaches at KSC are important nesting areas for loggerhead, green and possibly ridley turtles (Ref. 49 and 50). All three of these sea turtles are Federally protected. Additional information on these turtles is available in Appendix C. Surveys conducted in 1989, along the 10 km (6 mi) MINWR beach and 13 km (8 mi) of CNS beach, documented a combined total of 3,134 nests, of which 3,105 were loggerhead and 29 of which were green turtle nests. Nest predation has been lowered in recent years due to screening of nests after egg deposition and raccoon trapping by MINWR personnel. Hatchling disorientation continued to be a problem in 1989, particularly near CCAFS Launch Pads 40 and 41. The 1989 December freeze resulted in retrieval of 253 green and loggerhead and the subsequent release of revived individuals (Ref. 51).

6.6.4 BIRDS

Two hundred and sixty-seven species of birds have been documented as occurring on KSC and MINWR is considered to be one of the top 10 birding spots in the U.S. (reference). Ninety species nest at KSC, 111 species are regular winter visitors, and 66 species are considered to be transients (Ref. 52).

The herons, egrets, ibises, and other birds in the *Order Ciconiiformes* are collectively called wading birds. Thirteen species of wading birds are year-round residents on KSC and due to the large numbers of waders using the habitats here for feeding and nesting KSC is crucial for the conservation of several species (Ref. 53).

Roadside ditches are not used by as many wading birds for feeding as impoundments, but they are an important component of the overall feeding habitat. This is particularly true in the winter (Oct. – Jan.), when the number of waders inhabiting KSC decreases, but the numbers of waders feeding in roadside ditches increases (Figure 6-3**).**

Species and numbers of nests of wading birds were monitored yearly from 1987 through 2000, excluding 1991 and 1999 (Ref. 53). The number of nests for each species was variable between years (Table 6-3). *White ibis* accounted for 53 percent of the total nests counted.

KSC/MINWR support a large wintering waterfowl population and hunting takes place each year on MINWR from November through January for 25 days (MINWR Annual Report). Twenty-nine species of waterfowl have been documented on KSC, but 23 species regularly only the mottled duck is a year-round resident. Counts of mottled ducks are included in the wading bird feeding habitat surveys. They use impoundments and occasionally roadside ditches, but are most frequently seen along the edges of the estuary.

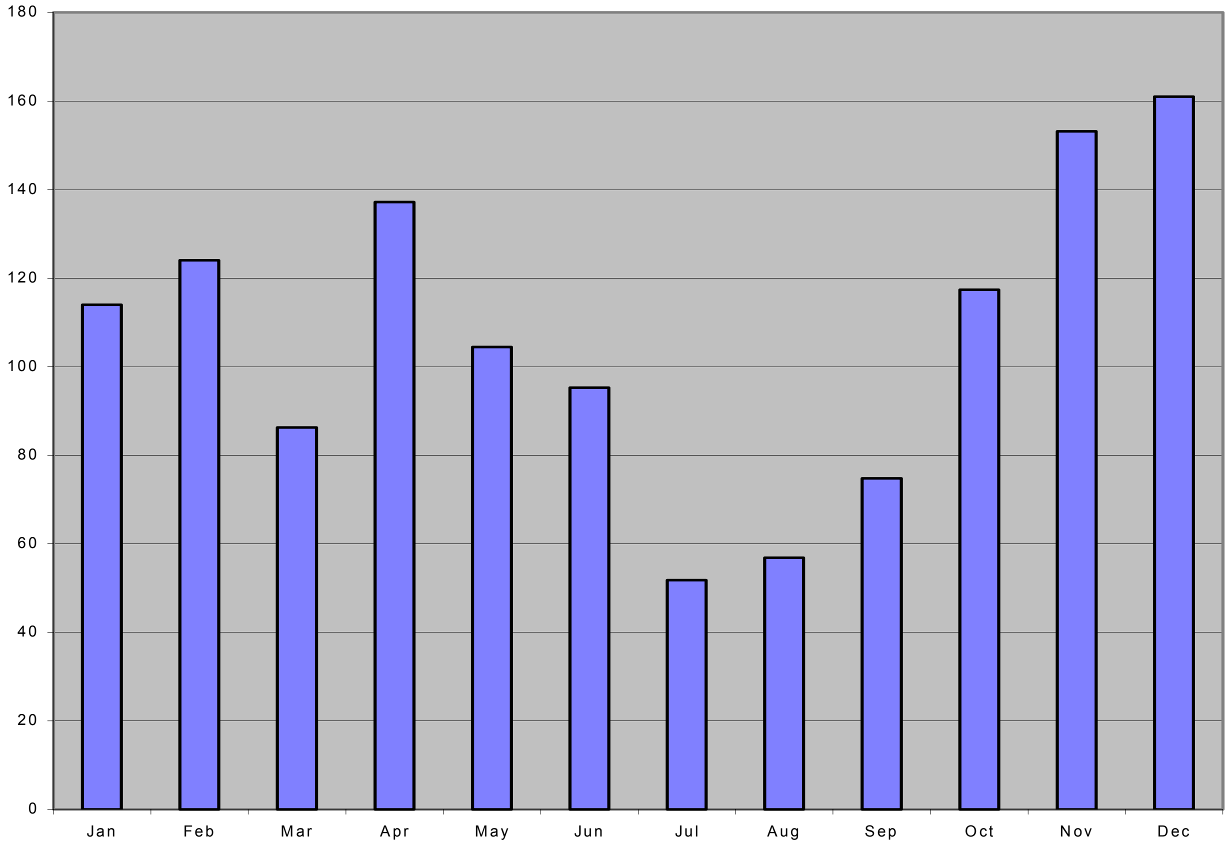

Figure 6-3. Average Total Birds by Month Over All Years in Ditches of KSC/MINWR from 1987 through 2002.

Table 6-3. Summary of Wading Bird Nesting on KSC/MINWR from 1987 through 2002.

SPECIES	1987	1988	1989	1990	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	TOTAL	AVERAGE
GBH	81	69	106	155	74	150	121	49	78	55	100	52	57	40	1187	85
GRE	354	304	420	592	236	307	228	279	333	97	528	202	227	214	4321	309
SNE	428	274	320	1224	184	222	316	171	207	310	264	165	152	23	4260	304
LBH	61	11	12	60	20	33	4	2	12	6	5	11	5	1	243	17
TCH	452	188	407	733	238	190	113	235	90	63	152	54	39	6	2960	211
REE	16	12	9	14	16	17	5	9	18	7	34	12	2	3	174	12
CAE	301	164	115	450	60	41	70	120	32	86	15	13	14	13	1494	107
BCN	32	10	3	13	5	11	2	0	2	2	8	2	1	1	92	7
WHI	801	715	1454	7226	764	1715	862	1737	1155	516	610	236	304	447	18542	1324
GLI	150	50	133	423	146	152	7	2	103	14	0	11	5	0	1196	85
ROS	1	4	4	6	28	14	10	10	12	2	5	8	14	15	133	9
WOS	0	45	122	121	0	0	0	0	0	0	0	0	0	0	288	21
TOTAL	2677	1846	3105	11017	1771	2852	1738	2614	2042	1158	1721	766	820	763	34890	2492

Note: 1991, 1999 not included due to missing data.

key: GBH - great blue heron; GRE - great egret; SNE - snowy egret; LBH - little blue heron; TCH - tricolored heron; REE - reddish egret; CAE - cattle egret; BCN - black-crowned night-heron; WHI - white ibis; GLI - glossy ibis; ROS - roseate spoonbill; WOS - woodstork.

6.6.5 MAMMALS

Thirty species of mammals have been documented on KSC (Table 6-2); this number includes five introduced species (see non-native wildlife discussion) and does not include the numerous species of dolphins and whales that occur offshore and occasionally wash up on KSC beaches.

A large bat colony exists in the SR 405 Bridge that crosses over SR 3. Two species, the Brazilian free-tailed bat and the southeastern bat, have been identified using the bridge as a roosting site. The bridge is also used as a maternity colony site and pre-fledging bats have been observed. In 1997, maintenance operations on the bridge were required that would potentially harm animals and disrupt the colony. The bats were excluded from parts of the bridge and allowed to use other parts until the work was completed. The colony is still present under the bridge and apparently suffered no ill effects from the temporary disruption.

A black bear population no longer occurs on KSC, even though an occasional individual will wander in from areas north of the property. Habitat fragmentation leading to smaller patches of suitable habitat and increased road mortality are probable causes for the loss of black bears on KSC.

Raccoons are a native meso-predator that is common in most habitats on KSC, but particularly abundant near water sources of all kinds. Raccoons have been documented as predators on wildlife and eggs of any kind that are available to them. In the 1970s, raccoons took nearly 100 percent of the marine turtle eggs that were deposited on the beaches of KSC, CNS, and CCAFS (Ref. 54). This trend continued until the responsible agencies implemented various raccoon predation control strategies on their respective beaches. Raccoons have also been implicated in the apparent decline of diamondback terrapin populations on KSC, because they have been observed eating adults and destroying nests to obtain eggs (Ref. 48).

Although there are no historical data on raccoon densities on KSC, it is thought that populations may have become unnaturally high when mosquito control impoundments were built in the early 1960s. The sudden access to marsh interiors and all of the resources within them may have caused a raccoon population explosion.

The largest mammalian predators remaining on KSC are the bobcat and river otter. There are no population estimates available for these animals and although they are commonly observed in many areas, the status of their populations is unknown. In data collected between 1992 and 1995, 31 bobcats and 17 otters were documented road mortalities on KSC. Many of the bobcats were juveniles, but all of the otters were adults. Loss of large predator populations can lead to increased densities of prey populations and a proliferation of meso-predators, such as the raccoon.

6.6.6 MANATEES

In 1977, KSC supported inventory actions by the USFWS in their endeavors to determine the abundance and distribution of the endangered manatee throughout Florida including the NASA/KSC property. The conclusion of those surveys indicated, that a large number of manatees were utilizing the same body of water that NASA intended to use for space operations. As much as 15 percent of the total manatee population of the U.S. is located within the waters immediately surrounding KSC (Ref. 55). It became clear that the National Environmental Policy Act (NEPA) and compliance with Endangered Species Act would best be met through monitoring of this endangered species and its habitat. Monitoring the distribution and abundance of manatees at KSC has been primarily performed through aerial surveys that have been funded by KSC intermittently from 1977- 1983, and almost continuously since 1984 (Ref. 51). Since 1991, KSC aerial surveys have been conducted during cold periods in conjunction with the FFWCC's population census, referred to as the Statewide Synoptic Survey.
The data have been shared with various agencies and universities, presented at scientific meetings and published in peer-reviewed journals. The raw 1977-1990 aerial survey data were made available to the public on a CD-ROM in a joint venture with the Florida Fish and Wildlife Conservation Commission through the Manatee GIS Working Group. (KSC has maintained a position on the Manatee GIS Working Group since its inception.) Data sets have been shared with FFWCC on many occasions over the years and more recent data were submitted (with restricted use) to FFWCC for their evaluation of speed zone regulations currently being developed. Data have also been shared with the "public" through invited presentations to environmental, educational, marine industry groups, the Brevard County Commission, Marine Mammal Commission and the USCOE.

In 1990, to further protect this endangered species, the USFWS created a sanctuary for manatees covering the majority of the KSC section of the Banana River. The USFWS officially designated the following areas at KSC as critical habitat: (1) the entire inland section of water known as the Indian River, from its northernmost point immediately south of the intersection of U.S. Highway 1 and Florida State Road 3; (2) the entire inland section of water known as the Banana River, north of KARS Park; (3) and all waterways between the Indian and Banana Rivers (exclusive of those existing manmade structures or settlements, which are not necessary to the normal needs of survival of the species). Critical habitat and areas of manatee concentration are delineated in Figure 6-4. KSC biologists also participate in the manatee-stranding network, for which, dead and live standings are reported to FFWCC and USFWS agencies. Those agencies collect the animals, rehabilitate, or file necropsy reports. Those data are maintained and archived by FFWCC.

6.7 NON-NATIVE WILDLIFE

At least 15 species of non-native wildlife have been documented on KSC. These fall into three basic categories: introduced exotics, non-native species extending their ranges, and feral populations of domesticated species.

6.7.1 INTRODUCED EXOTICS

The greenhouse frog (*Eleutherodactylus planirostris*) is native to the West Indies, but has become well established throughout peninsular Florida. It is nocturnal and prefers moist conditions, even within uplands habitats. It is one of our most common frogs.
Three species of lizards, the Cuban anole (*Anolis sagrei*), Indo-Pacific gekko (*Hemidactylus garnoti*), and Mediterranean gekko (*Hemidactylus turcicus*) were never reported in herpetological surveys done in the 1970s. All three species are now found around buildings and other facilities on KSC. The Cuban anole is native to Cuba, Jamaica, and the Bahamas, but is now well established in Florida, with populations also occurring in Texas, Louisiana, and Georgia. They probably were imported into the U.S. accidentally on landscaping plants. The Indo-Pacific gecko came to the U.S. from Southeast Asia and has spread throughout central and south Florida. One reason that these lizards are successful colonizers is that they are all self-fertilizing females. It only takes the introduction of one lizard into a new area to start a population. The Mediterranean gecko was introduced from the Mediterranean and is found in the Gulf states, Mexico, and Cuba. It is nocturnal, feeding on insects, and attracted to facility lighting.

The rock dove (*Columba livia*) or pigeon was introduced to North America from Eurasia in the 1800s. They are extremely common around human habitations and are often considered pests. On KSC and CCAFS, rock doves may take up residence in hangars and other open buildings, causing safety and sanitation concerns. Occasionally, the bodies of banded pigeons are retrieved and these birds typically have traveled thousands of miles from the northeastern U.S.

Sixty European starlings (*Sturnus vulgaris*) were intentionally introduced into New York City's Central Park in 1890, as a tribute to William Shakespeare. By 1950, they had become established across the entire U.S. Starlings are an ecological concern, because they often usurp cavities for nesting that are being used, or could be used, by native species, such as screech owls, woodpeckers, and wrens. Starlings gather in huge flocks and are capable of devouring mass quantities of food resources.

The English house sparrow (*Passer domesticus*) is the most widely introduced bird species in the world. In 1850, they were purposely imported from Europe to Brooklyn, New York, and within 20 years had spread in all directions across the continent. House sparrows are extremely aggressive and will extricate even larger birds from their nest sites. On KSC, they are extremely common around buildings and often get into buildings and hangars, causing safety and sanitation problems.

Originally native to South America, the nine-banded armadillo (*Dasypus novemcinctus*) extended its range into the U.S. through Texas in the late 1800s. It was intentionally introduced into Florida in the 1920s. Armadillos are extremely abundant, more so than is immediately evident, because they are generally crepuscular or nocturnal. They eat a variety of insects and other invertebrates, carrion, and eggs, and dig burrows for den and nesting sites. Nine-banded armadillos are not well studied and their impacts on native wildlife are not known. They could potentially compete with gopher tortoises for burrows and may eat eggs of native birds, amphibians, and reptiles.

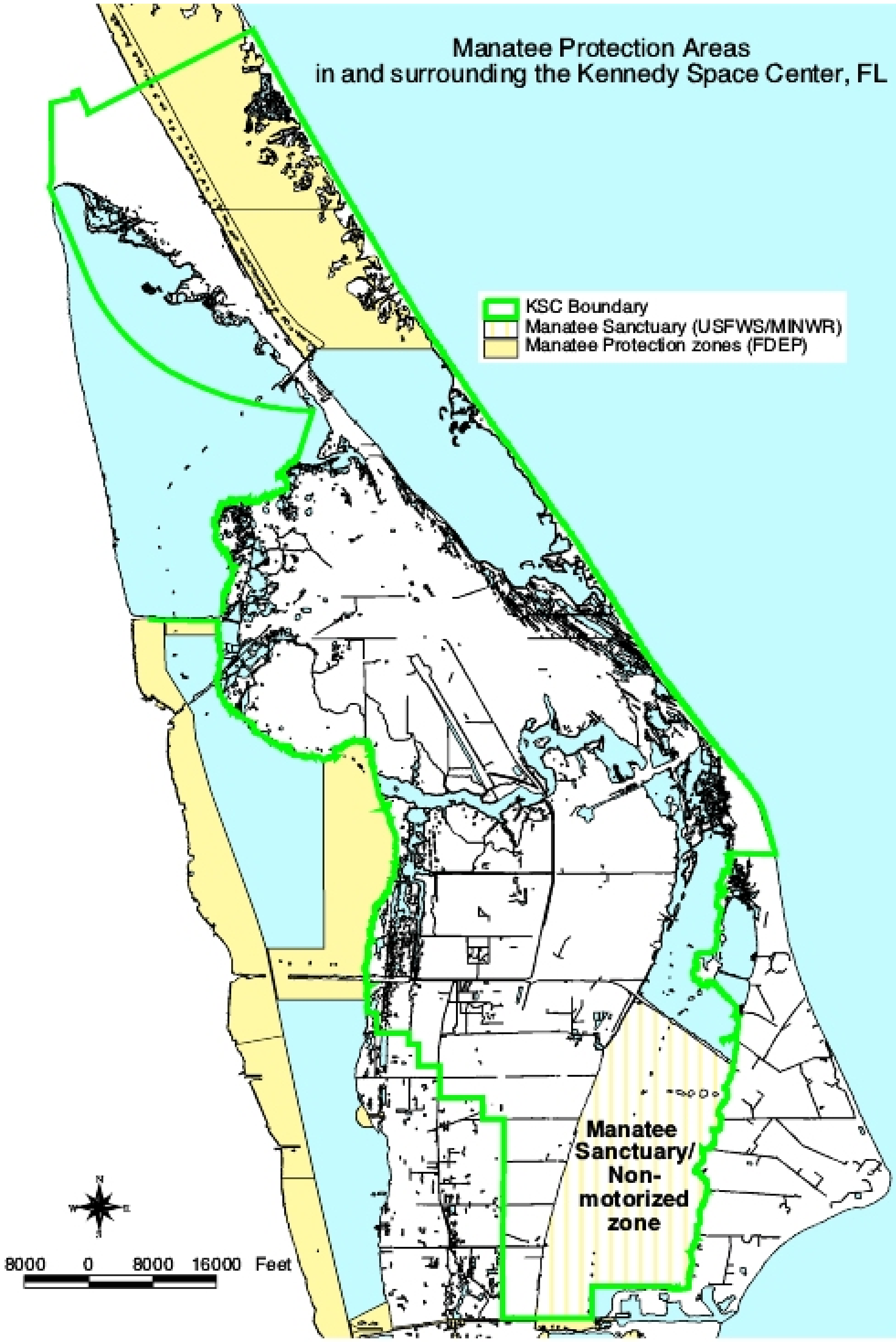

Figure 6-4. Manatee Protection Zones at Kennedy Space Center.

Black rats (*Rattus rattus*) were stowaways on the ships of European explorers to the U.S. in the mid-1500s. They are found primarily associated with buildings. However, during beach mouse surveys occurring from 1996 – 1998 on the dunes near the Space Shuttle launch pads, nine black rats were captured in traps. Because these animals constituted a threat to the Federally protected southeastern beach mouse, they were humanely destroyed. The extent to which black rats occur in natural habitats on KSC is not known, but could be a significant concern. Hunters brought the red fox (*Vulpes vulpes*) from England to the U.S. in the mid-18th century. They were released in the northeast U.S. and have since spread throughout most of the U.S. and Canada. Hunting kept populations in check for many years, but the devaluation of the fur market has caused red foxes to become more common. In some urban areas, they are considered to be pests and potential sources of rabies. The occurrence of red fox on KSC was documented from a single road mortality on SR 405 in front of the Space Station Processing Facility.

Typically associated with the southwest U.S., coyotes (*Canis latrans*) have taken advantage of human activities and impacts to increase their range to include every state in the U.S. except Hawaii. Although coyotes were introduced into Florida in the 1920s, for hunting with dogs, their natural range expansion was probably inevitable. The coyote's great success can be attributed to several factors. They are generalists in their habitat and food requirements and they produce large litters that mature quickly. Several of the other large predators that were competitors with the coyote (e.g., red wolf and panthers), have been extirpated from many areas. Most importantly, coyotes are able to capitalize on and benefit from human activities such as farming, ranching, and urbanization in general. Coyote numbers have been increasing in Florida during the last 20 years and the impacts on native wildlife are not well studied. They have been documented depredating marine turtle nests in north Florida. Coyotes may directly compete with bobcats for food resources. However, they may also help mitigate the loss of other large predators that once kept prey populations of raccoons, rodents, rabbits, etc., in check. Coyotes were reported on KSC and the adjacent CCAFS in 2002, but they are not yet common.

6.7.2 RANGE EXTENSIONS

The cattle egret (*Bubulcus ibis*) and brown-headed cowbird (*Molothrus ater*) are both examples of species that have managed to colonize Florida on their own (i.e., not introduced); both of these range extensions have occurred, because of habitat degradation caused by humans. The cattle egret reached Florida in the 1940s, via South America from Africa. Their entry was facilitated by deforestation, irrigation, and the cattle industry, all of which provided ample food resources. They may compete with native herons for food and nesting resources. The brown-headed cowbird is native to the Great Plains and was originally associated with the American bison. The proliferation of the cattle industry and the conversion of land to agriculture have allowed the cowbird to occupy the entire U.S. mainland. Cowbirds have completely abandoned nest building and deposit their eggs in the nests of other birds, often destroying the host birds' eggs in the process. Not all species of birds are susceptible to brown-headed cowbird parasitism, and as of yet, they have not been documented using Florida scrub-jay nests.

6.7.3 FERAL POPULATIONS OF DOMESTICATED SPECIES

Free-ranging feral house cats (*Felis domesticus*) are known to pose a significant threat to native species of wildlife. There is overwhelming evidence to show that feral cats eat adult birds, amphibians, and reptiles, their young, and eggs. They are also vectors for diseases infecting other wildlife (e.g., feline leukemia and distemper) and humans (e.g., rabies). In 1996, KSC workers concerned for the welfare of cats formed the Space Cats Club. By 1999, 100 feral cats had been trapped, neutered, and vaccinated, and were either adopted or housed in a closed facility on KSC. After 1999, operations were moved off KSC into Brevard County. At this time, feral cats populations do not appear to be large or constitute a major impact to KSC wildlife.

Before NASA took control of the property, that is now KSC, the area was home to many people who had livestock and/or citrus groves. As the people relocated to surrounding towns, their domestic hogs (*Sus scrofa*) were occasionally left behind. The mild central Florida winters and abundance of food resources made it possible for feral hog populations to explode. There are between 2,000 and 4,000 feral hogs within the KSC security area; this estimate does not include areas north of SR 402, south of SR 405, or west of SR 3 (Ref. 56). They constitute an environmental problem for a number of reasons. Hogs eat plants, small species of wildlife, and any eggs deposited on the ground. Their method of foraging is very destructive, because they turn over large amounts of dirt and cause significant soil disturbance, allowing increased opportunity for exotic and pest vegetation germination. Hogs can seriously damage the shallow freshwater marshes, that are crucial breeding habitat for amphibians and feeding habitat for a large number of species, including gopher tortoises, indigo snakes, and several wading birds. Feral hogs also pose a safety concern; an average of 14 hogs are killed on roads on KSC each year, causing property damage and injury to the KSC workforce. An average of 1,650 hogs were removed annually from 1998 and 2001 from KSC by trappers, that are required to capture and transport them out alive (Ref. 56). Unfortunately, this method is inefficient and does not sufficiently reduce hog populations.

6.8 REFERENCES

1. White, W.A. 1958. Some Geomorphic Features of Central Peninsular Florida. Geological Bulletin No. 41. Florida Geological Survey. Tallahassee. 92 pp.

2. White, W.A . 1970. The Geomorphology of the Florida Peninsula. Geological Bulletin No.51. Bureau of Geology, Florida Department of Natural Resources, Tallahassee. 164 pp.

3. Brown, D.W., W.E. Kenner, J.W. Crooks and J.B. Foster. 1962. Water Resources of Brevard County, Florida. U.S. Geological Survey, Report of Investigation No. 28.

4. Huckle, H.F., H.D. Dollar, and R.F. Pendleton. 1974. Soil Survey of Brevard County, Florida. USDA Soil Conservation Service, Washington, D.C.

5. Schmalzer, P. A., M. A. Hensley, and C. A. Dunlevy. 2001. Background characteristics of soils of Kennedy Space Center, Merritt Island, Florida: selected elements and physical properties. Florida Scientist 64(3):161-190.

6. U.S. Environmental Protection Agency. 1985. Freshwater Wetlands for Wastewater Management Handbook. September 1985. EPA 904/9-85-135. Atlanta, Georgia.

7. Florida Department of Transportation 1999 – the original map used the FLUCCS. We need this reference cleaned up some.

8. Schmalzer, P.A., S.R. Boyle, and H.M. Swain. 1999. Scrub ecosystems of Brevard County, Florida: a regional characterization. Florida Scientist 62:13-47.

9. Provost, M.V. 1967. Managing impounded salt marsh for mosquito control and estuarine resource conservation. LSU Marsh and Estuary Symposium. pp. 163-171.

10. Rey, J.R. and T. Kain.1989. A Guide to the Salt Marsh Impoundments of Florida. Florida Medical Entomology Laboratory, Vero Beach, Florida.

11. Bidlingmayer, W.L. and E.D. McCoy. 1978. An inventory of saltmarsh mosquito control impoundments in Florida. Unpublished Rept. to Fish and Wildlife Serv., U.S. Dept. of Interior. 103 pg., 173 maps, Appendices I-III.

12. Harrington, R.W. and E.S. Harrington. 1961. Food selection among fishes invading a high subtropical salt marsh from the onset of flooding through the progress of a mosquito brood. Ecology 42(4):646-666.

13. Harrington, R.W. and E.S. Harrington. 1982. Effects on fishes and their forage organisms of impounding a Florida salt marsh to prevent breeding by salt marsh mosquitoes. Bull. Mar. Sci. 32:523-531.

14. Gilmore, R.G., D.W. Cooke and C. J. Donohoe. 1982. A comparison of fish populations and habitat in open and closed salt marsh impoundments in east-central Florida. N.E. Gulf Sci. 5:25-37.

15. Gilmore, R.G. 1987. Fish , macrocrustacean, and avian population dynamics and cohabitation in tidally influenced impounded subtropical wetlands. pp. 373-394. IN Whitman, W.R. and W.H. Meredith (eds). Waterfowl and Wetlands Symposium. Delaware Dept. of Natural Resources. 522 pp.

16. Rey. J.R., J. Shaffer, D. Tremain, R.A. Crossman, and T. Kain. 1990a. Effects of re-establishing tidal connections in two impounded subtropical marshes on fishes and physical conditions. Wetlands 10:27-45.

17. Rey. J.R., M.S. Peterson, T.R. Kain, F.E. Vose and R.A. Crossman. 1990b. Fish populations and physical conditions in ditched and impounded marshes in east-central Florida. N.E. Gulf Sci. 11(2):163-170.

18. Phillips, R. C. 1960. Observations on the ecology and distribution of the Florida seagrasses Professional Paper Series No. 2. Florida State Board of Conservation Marine Laboratory, St. Petersburg, Florida 72 p.

19. Orth, R. J., and K. A. Moore. 1983. Chesapeake Bay: An unprecedented decline in submerged aquatic vegetation. Science 222:51-53.

20. Kenworthy, W. J., and D. E. Haunert. 1991. Results and recommendations of a workshop convened to examine the capability of water quality criteria, standards and monitoring programs to protect seagrasses from deteriorating water transparency. NMFS-SEFC-287. NOAA Technical Memorandum. 151 p.

21. Short, F. T. 1991. Light limitation on seagrass growth. P. 37-40, In W. J. Kenworthy and D. E. Haunert (eds.), Results and recommendations of a workshop convened to examine the capability of water quality criteria, standards and monitoring programs to protect seagrasses from deteriorating water transparency. NMFS-SEFC-287. NOAA Technical Memorandum 151 p.

22. Dawes,C.D., D. Hanisak, and W. J. Kenworthy. 1995. Seagrass biodiversity in the Indian River Lagoon. Bulletin of Marine Science 57: 59-66.

23. Kenworthy, W. J., M. S. Fonseca, D. E. McIvor, and G. W. Thayer. 1988. The submarine light regime and ecological status of seagrasses in Hobe Sound, Florida. Annual Report, National Marine Fisheries Service, Beaufort Laboratory. 55 p.

24. Virnstein, R. W. 1995. Seagrass landscape diversity in the Indian River Lagoon, Florida: The importance of geographic scale and pattern. Bulletin of Marine Science 57: 67-74.

25. Provancha, J. A. and M. J. Provancha. 1988. Long-term trends in abundance and distribution of manatees (Trichechus manatus) in the northern Banana River, Brevard County, Florida. Marine Mammal Science 4:323-338.

26. Provancha, J. A. and C. R. Hall. 1991. Observations of associations between seagrass beds and manatees in east central Florida. Florida Scientist 54:87-98

27. Lipkin, Y. 1975. Food of the red sea dugong (Mammalia: Sirenia) from Sinai, Israel. Journal of Zoology 24:81-98.

28. Ogden, J. C. 1976. Some aspects of herbivore-plant relationships on Caribbean reefs and seagrass beds. Aquatic Botany 2:103-116.

29. Packard, J. M. 1984. Impact of manatees Trichechus manatus on seagrass communities in eastern Florida. Acta. Zoologica Fennica 172:21-22.

30. Ledder, D. 1986. Food habits of the West Indian manatee in South Florida. Master's Thesis, Department Biological Oceanography, University of Miami. Miami, Florida. 113 p.

31. Lefebvre, L. W., D. P. Domning, W. J. Kenworthy, D. E. McIvor, and M. E. Ludlow. 1988. Manatee grazing impacts on seagrasses in Hobe Sound and Jupiter Sound, January-February 1988. Appendix B. 34 p. In W. J. Kenworthy, M. S. Fonseca, D. E. McIvor, and G. W. Thayer. The submarine light regime and ecological status of seagrasses in Hobe Sound, Florida. Annual Report, National Marine Fisheries Service, Beaufort Laboratory.

32. Daubenmire, R. 1968. Plant Communities, A Textbook of Plant Synecology. Harper and Row, New York. 300 p.

33. Provancha, Jane A. and Douglas M. Scheidt. 1999. Long-Term trends in Seagrass beds in the Mosquito Lagoon and Northern Banana River, Florida. Chapter 14 In S.A. Bortone, ed. Seagrasses: Monitoring, Ecology, Physiology, and Management. CRC Press. Boca Raton, Florida. 384 pages.

34. Gilmore, R.G. 1977. Fishes of the Indian River Lagoon and Adjacent Waters, Florida. Bull. Florida St. Mus., Biol. Sci. 22:101-148.

35. Gilmore, R.G., C.J. Donohoe, D.W. Cooke and D.J. Herrema. 1981. Fishes of the Indian River Lagoon and Adjacent Waters, Florida. Harbor Branch. Tech Report No. 41.

36. Gilmore, R.G., P.A. Hastings and D.J. Herrema. 1983. Ichthyofaunal Additions to the Indian River Lagoon and Adjacent Waters, East-Central Florida. Florida Sci. 46:22-30.

37. Snelson, F.F., Jr. 1983. Ichthyfauna of the Northern Part of the Indian River Lagoon System, Florida. Florida Sco. 46:187-206.

38. Steward, J.S. and J.A. Van Arman. 1987. Indian River Lagoon Joint Reconnaissance Report. St. Johns River Water Management District and South Florida Water Management District.

39. Morris, Frederick, W. 1989. Bibliography of the Indian River Lagoon Scientific Information System. St. Johns River Water Management District.

40. Virnstein, R.W. 1990. The Large Spatial and Temporal Biological Variability of Indian River Lagoon, Florida. Florida Scientist 53(3):226-238.

41. Brown-Peterson, N., R.W. Eames. 1990. Idthyofauna Associated with Spoil Islands in Indian River Lagoon, Florida. Florida Scientist 53(3):226-238.

42. Schmidt, T.H., L.M. Ehrhart, F.F. Snelson, Jr. 1988. Notes on the occurrence of Rays (*Elasmobranchii, Batoidea*) in the Indian River Lagoon System, Florida. Florida Scientist 51(2):121-128.

43. Snelson, F.F., S.E. Williams-Hooper, T.H. Schmidt. 1988. Reproduction and Ecology of the Atlantic Stingray, Dasyatis sabina, in Florida Coastal Lagoons. Copeia 3:729-739.

44. Snelson, F.F., S.E. Williams-Hooper, T.H. Schmidt. 1989. Biology of the Huntnose Stingray, Dasyatis sayi, in Florida Coastal Lagoons. Bull. Mar. Sci. 45(1):15-25.

45. St. Johns River Water Management District, South Florida Water Management District. 1989. Surface Water Improvement and Management (SWIM) Plan for the Indian River Lagoon. 100 pp.

46. Virnstein, R.W. 1990. The Large Spatial and Temporal Biological Variability of Indian River Lagoon, Florida. Florida Scientist 53(3):226-238.

47. Peterson, M.S., and R.G. Gilmore. 1991. Eco-Physiology of juvenile snook *Centropomus undecimalis* (Bloch): Life-History implications. Bull. Mar. Sci. 48(1):46-57.

48. Seigel, R.A., Smith, R.B., Demuth, J., Ehrhart, L.M., and Snelson, Jr., F.F. 2002. Amphibians and Reptiles of the JFKSC, FL. A Long-Term Assessment of a Large Protected Habitat (1975-2000). Florida Scientist 65:1-12.

49. NASA. 1979a. Final Environmental Impact Statement. John F. Kennedy Space Center, Florida.

50. National Park Service. 1986. Cape Canaveral National Seashore Resources Management Plan. Canaveral National Seashore, Florida.

51. U.S. Fish and Wildlife Service. 1990. Annual Narrative Report Calendar Year 1989. U.S. Department of Interior Fish and Wildlife Service National Wildlife System. Merritt Island National Wildlife Refuge, Merritt Island, Florida.

52. Breininger, D.R., Barkaszi, M.J., Smith, R.B., Oddy, D.M., and Provancha, J.A. 1994. Endangered and Potentially Endangered Wildlife on JFKSC and Faunal Integrity as a Goal for Maintaining Biological Diversity. NASA Technical Memorandum 109204. 451 pp.

53. Stolen E.D., Breininger, D.R., and Smith, R.B. 2002. Analysis of Wading Bird Use of Impounded Wetland Habitat on KSC/MINWR 1987 – 1998. NASA Technical Memorandum 211173. 70 pp.

54. Ehrhart 1983. Marine Turtles of the Indian River Lagoon System. Florida Scientist. 46:337-346.

55. Hall, C.R., Breininger, D.R., Schamlzer, P.A., Drese, J.H., Provancha, M.J., Provancha, J.A. and Dreschel, T.W. 1986. Polygeneration Project Baseline Environmental Monitoring Program: Final Report. NASA/KSC Biomedical Office. John F. Kennedy Space Center, Florida.

56. Rosenfeld, A. 2002. Feral Hog Management in MINWR – Analysis of Current Management. Draft Report to MINWR. 55 pp.

SECTION VII

THREATENED AND ENDANGERED SPECIES

7.1 REGULATORY OVERVIEW

The Endangered Species Act provides guidance regarding the management and protection of certain species based on determinations made regarding their relative ability to survive. The U.S. Fish and Wildlife Service (FWS) is responsible for determining which species are listed as either Threatened or Endangered and for maintaining this listing.

In addition, Section 7 of the Statute provides for a consultation process between the Service and any Federal agency that may, through one of its proposed actions, impact one of these species or their critical habitat.

The State of Florida also develops and maintains its own list. The Florida Fish and Wildlife Conservation Commission (FFWCC) Endangered Species Coordinator is responsible for the review of species, designating their status and formally listing them in State's Official List of Endangered and Potentially Endangered Fauna and Flora in Florida. This provides a comprehensive directory of the biota requiring special consideration in the State of Florida.

A list of Federally and State-protected animals known to occur at the Merritt Island National Wildlife Refuge (MINWR) is given in Table 7-1. Individual species accounts are provided in Appendix D. Details of research and other information on protected species are given in the appropriate sections below.

7.2 REPTILES

KSC is home to three species of marine turtles that nest on the beaches: loggerheads, green turtles, and leatherbacks.

Harvesting of green turtles from the Indian River Lagoon System began in about 1878, and early reports (Ref. 1 and 2) describe a turtle fishery that took many green turtles. Efforts were concentrated more in the south end of the system near Sebastian and Ft. Pierce, rather than in the northern end near KSC. Green turtles were severely affected by commercial harvesting, and by 1895, the captures of turtles from the Indian River Lagoon System (IRLS) had dropped sharply (Ref. 2).

Documented historical evidence for marine turtles' occurrence in Mosquito Lagoon begins with an anecdotal statement that 150 green turtles were exported from Mosquito Lagoon in 1879. Scientific research on marine turtles in Mosquito Lagoon began in earnest in 1975 (Ref. 3). Four species were found in the area: green turtles and loggerheads were most common, but during five years of netting, two Kemp's ridleys and one hawksbill were also captured. Mosquito Lagoon is believed to be a nursery habitat for green turtles and loggerheads; the size classes present range from post-yearling to sub-adults. Capture rate for Mosquito Lagoon was 0.67 turtles/day; this

Table 7-1. Wildlife Species Known to Occur on KSC that are Protected Federally and/or by the State of Florida.

SCIENTIFIC NAME	COMMON NAME	LEVEL OF PROTECTION	
Amphibians and Reptiles		**STATE**	**FEDERAL**
Rana capito aesopus	Florida gopher frog	SSC	
Alligator mississippiensis	American alligator	SSC	T(S/A)
Caretta caretta	Loggerhead	T	T
Chelonia mydas	Atlantic green turtle	E	E
Dermochelys coriacea	Leatherback sea turtle	E	E
Gopherus polyphemus	Gopher tortoise	SSC	
Drymarchon couperi	Eastern indigo snake	T	T
Pituophis melanoleucus mugitus	Florida pine snake	SSC	
Birds			
Pelecanus occidentalis carolinensis	Eastern brown pelican	SSC	
Egretta thula	Snowy egret	SSC	
Egretta caerulea	Little blue heron	SSC	
Egretta tricolor	Tricolored heron	SSC	
Egretta rufescens	Reddish egret	SSC	
Eudocimus albus	White ibis	SSC	
Ajaia ajaja	Roseate spoonbill	SSC	
Mycteria Americana	Wood stork	E	E
Haliaeetus leucocephalus	Bald eagle	T	T
Falco peregrinus tundrius	Arctic peregrine falcon	E	
Falco sparverius paulus	Southeastern American kestrel	T	
Sterna antillarum	Least tern	T	
Rynchops niger	Black skimmer	SSC	
Aphelocoma coerulescens	Florida scrub-jay	T	T
Mammals			
Peromyscus polionotus niveiventris	Southeastern beach mouse	T	T
Podomys floridanus	Florida mouse	SSC	
Trichechus manatus	West Indian manatee	E	E
Key: SSC = Species of Special Concern; T(S/A) = Threatened because of similarity of appearance to another protected species; T = threatened; E = endangered.			

rate is an order of magnitude lower than the capture rate near Sebastian (Ref. 4), but greater than the 0.02 turtles/day reported for the northern section of the Indian River (Ref. 5). Much data on marine turtles residing in Mosquito Lagoon were gathered opportunistically during cold-stunning events in 1977, 1978, and 1989. When the water temperatures fall below 8^{o}C, marine turtles become lethargic and float to the surface, and can die if not rescued and rehabilitated (Ref. 6). During the 1989 freeze, 246 green turtles and 10 loggerheads were recovered from Mosquito Lagoon and nearby waters of the northern Indian River, representing the largest recorded cold-stunning event in this region. Twenty-seven percent of the turtles recovered were either dead or moribund.

The relative abundance, distribution, and status of the marine turtle population inhabiting Mosquito Lagoon are currently being assessed. Primary goals are to compare the present-day population to baseline data collected in 1976-1979, to determine regional "importance value", and determine the sex ratio and genetic characteristics of marine turtles in this estuary. Methods consist of sampling on a seasonal basis using two large mesh tangle nets. Basic morphometric data, evaluation of condition, photography, tagging, and blood samples are recorded from captured animals that are then released.

Approximately 100 individuals have been captured since this project started. Our species ratio favors green sea turtles over loggerheads, the inverse of that observed in the late 1970s. Based on a sub-sample, the sex ratio is also skewed towards females and determined to be 94.4 percent for greens and 66.6 percent for loggerheads. Catch per unit effort (CPUE) is a standardized technique to compare sea turtle netting worldwide (Ref. 4). Our CPUE values indicate that green turtles are much more abundant today than the 1970s; conversely, loggerhead captured indicate a slight decline in their numbers in the 1990s. A series of recaptures occurred in our study site confirming the presence of a resident population. These sub-adults use the benthic lagoonal habitat for several years until they reach reproductive maturity when they travel to their natal beaches. Several turtles originally tagged in Mosquito Lagoon have been recaptured as far away as Cuba. Deoxyribonucleic Acid (DNA) analyses of sea turtles captured in Mosquito Lagoon revealed the presence of sea turtles originating in Florida, Mexico, Aves Island, Surinam and Costa Rican rookeries. This indicates the significant ecological value Mosquito Lagoon has in the sea turtle life cycle.

An additional difference in the netting results from the 1970s vs. the current effort is the occurrence of fibropapillomatosis (FP). This debilitating disease is transmitted by a retrovirus that manifests itself as tumors. Tumors may grow to a considerable size, usually attached to soft-tissues such as the eyes and flippers. They can occlude the sea turtle’s vision, potentially leading to starvation. Much research is being done to determine the biology and cure for FP. Occasionally, recaptured individuals showed that FP tumors can also regress. FP was not observed in any green turtles in the 1970s in Mosquito Lagoon. Unfortunately, today 57 percent of the green turtles have FP tumors. FP is extremely rare in loggerhead sea turtles.

The KSC/MINWR beaches, as well as those of Canaveral National Seashore (CNS) and Cape Canaveral Air Force Station (CCAFS), provide excellent nesting habitat for marine turtles and is primarily used by the Atlantic loggerhead and the Florida green turtle. Because of security restrictions to the general public, this area is one of the rare beaches in Florida where sea turtles can nest relatively undisturbed.

Much information is known about sea turtles’ nesting ecology, particularly related to nesting sites, because they have high nesting-site fidelity. The KSC and adjacent beaches are included in a major loggerhead sea turtle rookery located along the southeast U.S. coast. This aggregation is believed to be the second largest in the world with tens of thousands of females nesting annually. Although it is considerably smaller than the loggerhead aggregation, Florida's green turtle nesting rookery is the second largest in the Western Hemisphere. In 1999, 479 green turtle nests were recorded in Florida. Florida is the only state in the continental United States with regular nesting by the leatherback turtle; 558 nests were recorded in Florida in 1999. Indeed, three of the top 10 sea turtle nesting beach sections are located within KSC/CNS/CCAFS property.

For the purpose of assessing trends, nesting activity in Florida has been monitored since 1989, at a core set of 27 "index beaches" (within a set of 32 beaches that are presently monitored). The KSC beach is one of these core “index beaches”. The resulting database allows analysis by species, date, location and nesting success (nesting or non-nesting emergence). During this period, the annual number of loggerhead nests at the core set of index beaches ranged from 39,091 to 59,917 nests, green turtle nests ranged from 267 to 4,229 nests, and leatherback nests ranged from 27 to 230 nests. Nesting numbers for green turtles showed a clear biennial periodicity, with odd years having low nesting and even years having high nesting. A cyclic trend also exists for loggerheads and appears to have a three and four-year peaks in nesting activity. Over this monitoring period of study, loggerhead and green turtle nesting in Florida appears to be stable or increasing and leatherback nesting is increasing significantly.

The following loggerhead nesting data are from the secured beach near the Space Shuttle launch pads. This beach is 10 km (6 mi) long and is located between the CNS managed section of KSC to the north and CCAFS to the south. The loggerhead annual nesting mean for the last 10 years was 1,252 ± 297 nests; nesting on the KSC beach remained fairly constant and averaged 124.7 nests/km/year. Nesting totals, however, for several years were above the overall mean.

Artificial lighting on marine turtle nesting beaches disrupts the ability of hatchlings and adults to find the sea from their nest, an effect termed "disorientation". Disorientation from artificial lighting causes thousands of hatchling deaths each year in Florida and is a significant marine turtle conservation problem. Long-term monitoring of this threat involves an annual statewide effort to gather information from disorientation reports used in facilitating light management on nesting beaches and research for additional remedies for the threats caused by lighting. Disorientation surveys of the KSC beach start on May 1st and continue until the beginning of October. Surveys are conducted to observe and identify points-of-light sources on KSC, CNS, and CCAFS beaches that have potential to disorient adult or hatchling sea turtles.

On KSC, few adult sea turtles disorient and the majority of recorded disorientations are by hatchlings. KSC’s hatchling disorientations averaged 12 percent before 1993, when a Light Management Plan (LMP) was implemented by CCAFS. This plan significantly reduced the Air Force’s lighting impact on the KSC beach and the hatchling disorientations were reduced to an average of 3-5 percent.

A relatively low rate of disorientations was observed until the 2000 hurricane season damaged the dune regions on the northern KSC beach. When nests were laid in the proximity of these areas, disorientations were observed. Unshielded lights on CCAFS also contributed to a relatively high annual mean sea turtle disorientation for the 2001-2002 nesting seasons and the average was 10 percent. In order to abate sea turtle disorientations at KSC, an LMP was implemented in 2001. The objective of this plan was to eliminate unnecessary exterior light used at the Shuttle Launch Complexes 39A and 39B and their associated facilities. When lighting is required for safety or operational reasons, either high-pressure sodium or low-pressure sodium lights are acceptable for use.

Gopher tortoises are a State-protected Species of Special Concern. They are long-lived terrestrial animals that dig burrows to use as refugia from inclement weather, fire, and predators. The burrow provides important habitat for hundreds of invertebrate and vertebrate species, earning the gopher tortoise the distinction of being a “keystone species”. Several of the animals that use tortoise burrows are also State or Federally protected, and the value of healthy, reproductive gopher tortoise colonies cannot be overstated. Several studies of gopher tortoises have been conducted on KSC. In the mid-1980s, 112 plots were established in tortoise habitats to determine burrow and tortoise densities, and to develop corrections factors to correlate the number of burrows seen to the number of tortoises in the population (Ref. 7). From 1989 – 1991, tortoises were radio-tracked to determine home range sizes and numbers of burrows used (Table 7-2; Ref. 8). Tortoise burrows were found in the typical high, dry habitats, but radio tracking showed that they are also dependent on wetter habitats, such as the freshwater swales for feeding. Work began in 1998, to determine if a deadly bacterial disease, Upper Respiratory Tract Disease (URTD), was present in KSC gopher tortoise populations. Antibodies for URTD were found in several populations and spread across KSC and CCAFS (Ref. 9). Monitoring of URTD continues and several sites may potentially have had die-offs that could be contributed to URTD (Ref. 10).

Table 7-2. The Mean Home Range Size (ha) and Number of Burrows Used by Radiotagged Gopher Tortoises on KSC.

	Home Range Size (ha)		Number of Burrows Used	
	Males (n=10)	Females (n=4)	Males (n=10)	Females (n=4)
Mean	1.9	1.6	16.6	9.6
Standard Deviation	0.6	0.4	8.8	5.9

Other than the low-intensity URTD monitoring that continues, most of the work currently occurring with gopher tortoises involves moving them from harm’s way for operational requirements. New construction, renovations, repairs, and environmental cleanup efforts often occur in areas occupied by tortoises. In these instances, the sites are surveyed to determine the locations of all burrows, which are marked. The interiors of the burrows are examined with an infrared burrow camera. When tortoises are found, they are removed from the burrow either by bucket trapping or excavation with a backhoe. In most instances, the tortoises are relocated a short distance away, out of harm’s way, but still within their home range and familiar surroundings. When the occasional longer distance relocation is required, suitable recipient sites are identified, ideally in newly restored habitat that is capable of supporting an increased tortoise population.

The eastern indigo snake is the longest snake in the U.S., reaching lengths greater than 2.5 m (8 ft). They are Federally listed as a threatened species, but protection and conservation are difficult. There is little life history information available, and no reliable survey techniques exist to determine presence, absence, or abundance at a site. Radiotracking of eastern indigo snake first took place on KSC between 1990 and 1992. A small number of snakes were tagged to determine home range sizes and habitat use. From 1998 – 2002, in a studied funded by a private wildlife foundation with support from NASA and the USFWS, more than 70 eastern indigo snakes were captured throughout Brevard County and radio-tracked. Home range sizes were variable with males generally using a larger area than females (see Table 7-3). It was found that indigos use a wide variety of habitats, included suburban areas where they regularly come into contact with people. Road mortality and intentional killing by humans were two major sources of mortality. Development resulting in the fragmentation of habitat is the greatest threat to indigo snake populations for a number of reasons: snakes are forced to cross more roads in their daily travels, they are more likely to be seen and possibly killed by people, and the fire-maintained habitats that they use are degraded due to lack of fire (Ref. 11).

Table 7-3. Home Range Sizes for Radiotagged Eastern Indigo Snakes on KSC.

Snake (Sex)	Months (Tracked)	Home Range Size (Ha) (ac)
1 (male)	6	64.6 (159.6)
2 (male)	10	77.6 (191.7)
3 (male)	16	115.5 (285.4)
4 (male)	11	142.9 (353.1)
5 (male)	9	157.2 (388.4)
6 (male)	10	326.6 (807.0)
1 (female)	15	19.6 (48.4)
2 (female)	27	34.0 (84.0)
3 (female)	15	62.6 (154.7)
4 (female)	10	101.4 (250.6)

Lack of a reliable survey method for eastern indigo snakes was deemed the number one problem facing protection and conservation of the species at the Eastern Indigo Snake Summit held in March 2000. Currently, two standard herpetological survey methods are being tested on KSC in a study funded by USFWS and supported by NASA. Twenty-four drift fence arrays, each with one large box trap and two large funnel traps, are in operation at three sites in four different habitat types. In addition, road surveys are being conducted 40 times per month on 9.5 km (5.9 mi) of road. The two techniques will be evaluated and compared, based on effectiveness and cost-efficiency, for both short-term and long-term monitoring and research applications.

7.3 BIRDS

The bald eagle, wood stork, and Florida Scrub-jay are protected under the Endangered Species Act, and 11 additional species are protected by the State of Florida. All birds, except exotics, that have been introduced, receive Federal protection under the Migratory Bird Treaty Act (16 U.S.C., pp. 703-712, July 3, 1918, as subsequently amended).

Bald eagles arrive each year on KSC in the fall, nest during the winter, and leave KSC in early spring after the young have fledged. Records of bald eagle nesting have been kept on KSC continuously since 1978, by MINWR and/or FFWCC. The numbers of nests have increased steadily over the years, in keeping with the general recovery of bald eagle populations in the U.S. since the banning of dichlorodiphenyltrichloroethane (DDT). Within the last five years (1998 – 2002), the number of nests has ranged between 13 and 18, and average number of known fledglings per year is 13.2. Eagle nest trees are protected on KSC by a 230 - 458 m (750 – 1500 ft) no-activity zone, surrounded by an additional 230 - 1609 m (750 ft – 1 mi) permitted-only activity zone. One nest located on KSC is very well known locally as it has been used almost continuously for at least 40 years. The nest measures 0.2 m (7 ft) in diameter and is 3 m (10 ft) deep. It is a regular stop for KSC tour buses and has been equipped with video and still cameras during different time periods, providing an incredible up-close look at life in the nest. A map of recent eagles nests sites is provided in Figure 7-1.

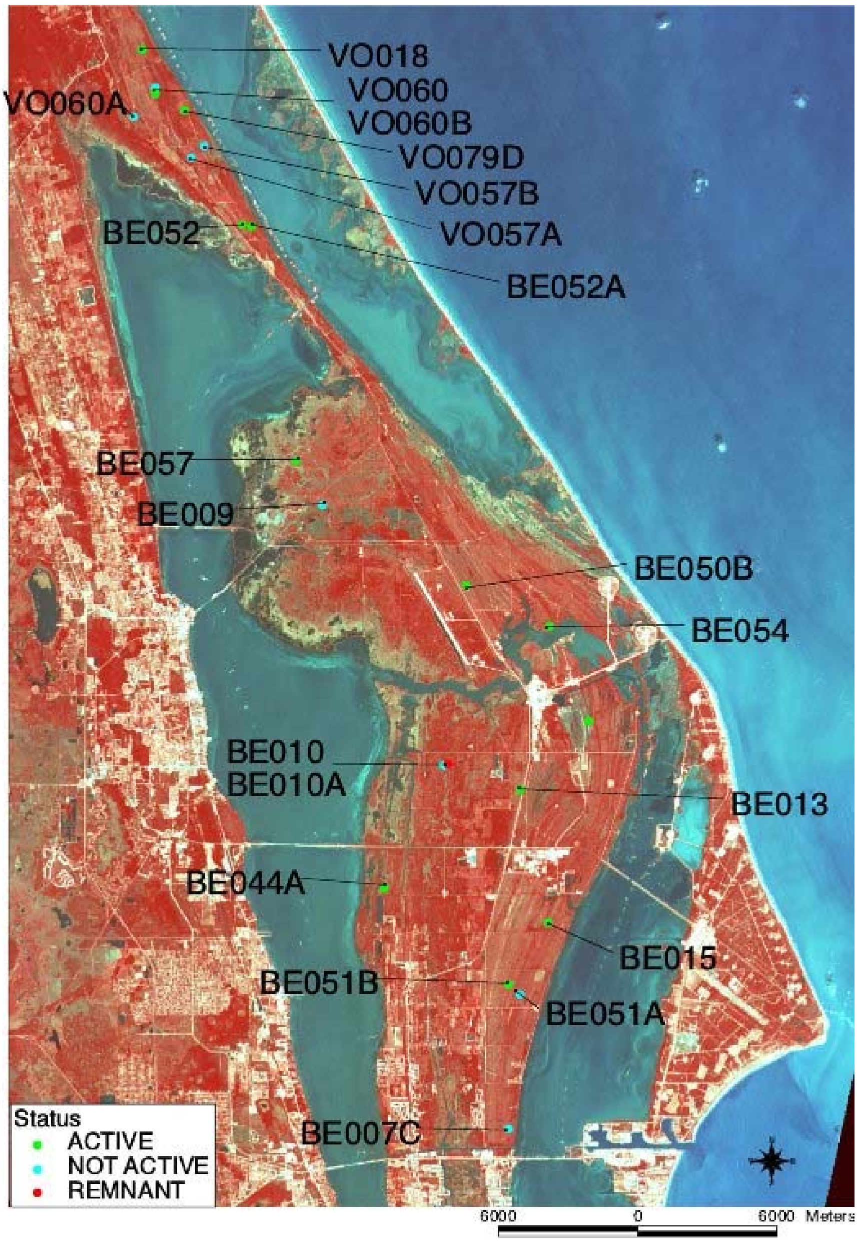

Figure 7-1. Bald Eagle Nesting Sites for 2002.

The wood stork is Federally listed as endangered and six of the other species are protected by the State (Table 7-1). Long-term monitoring of feeding sites began in 1987, and has been done monthly. Sites surveyed include a sample of mosquito control impoundments, a portion of the edge of the estuary and associated creeks, and a sample of roadside ditches. It has been found that wading birds prefer feeding in open water habitats, but will feed in marsh grasses, particularly when the water level is high in the impoundments (Ref 12). Wood stork nesting occurred in large numbers prior to 1985, and then again in smaller numbers from 1988 - 1990, but has not been documented since 1990. Roseate spoonbills were first documented nesting on KSC in 1987 (Ref. 13), and their numbers have increased steadily since that time. Brown pelicans and double-crested cormorants also frequently nest in the wading bird colonies in large numbers.

The Florida Scrub-jay is a Federally protected threatened species that was elevated from subspecies status in 1997. The four largest remaining populations of Scrub-jays occur on KSC, CCAFS, Ocala National Forest, and the mainland of Brevard County and Indian River County (Ref. 14). KSC has a potential population size of 700 breeding pairs, but the population declined to half this number, because of habitat degradation (Ref. 15, 16, and 17). Research on color-banded populations on KSC began in 1987, and showed that territory sizes averaged 10 ha (24 ac) (Ref. 18). Major sources of mortality for adults are hawk predation and road mortality (Ref. 19). Monitoring of Scrub-jay nests has also been done since 1987. A large number of nests (between 80 and 43 percent of the total, depending on the site) are depredated, resulting in a decreasing population in some areas (Ref. 20). Two years of remote recording of egg and nestling predation events found that 13 of 19 were due to yellow rat snakes. Radio-tracking data showed that small mammals, other birds, and snakes readily eat the fledgling Scrub-jays before they become efficient fliers.

Florida Scrub-jays are restricted to shrub lands, that have many scrub oaks and few trees (Ref. 21). They have their greatest demographic success when territories include a matrix of recently burned scrub (<3 years since fire and patches of scrub oaks that are 120-170 cm (47-66 in) tall (Ref. 22, 23, and 24). Fragmentation of scrub habitat and isolation of small patches of scrub result in habitat degradation from fire suppression, increased predation, and increased road mortality (Ref. 17 and 20). Major Scrub-jay populations that have been studied in four areas on KSC are shown in Figure 7-2.

7.4 MAMMALS

The southeastern beach mouse and the manatee are Federally protected as threatened and endangered, respectively, and the Florida mouse is protected by the State of Florida (Table 7-1).

Small mammal trapping, primarily done in coastal habitats, expected to support southeastern beach mouse populations has provided data on several species, including beach mice, cotton mice, and cotton rats. A distribution survey completed in 1991, provided information on high-density and low-density areas located within the KSC coastal strand habitat. From 1996 – 1998, research was conducted to investigate the differences in beach mouse populations occupying areas affected by shuttle launch deposition vs. populations in areas not affected. Two areas (one near LC-39A and one near LC-39B) with the most frequent occurrence of near-field deposition were selected as treatment sites, and two areas not impacted by near-field disposition were

Figure 7-2. Scrub and Major Scrub-jay Populations on KSC.

selected as reference sites. A total of 479 beach mice were captured, 64 percent of which were adults, 28 percent were juveniles, and 4 percent were dependent young. Preliminary results indicate that the populations differed between the four sites, but no clear trend could be attributed directly to launch deposition.

In 1991, a presence and absence survey was conducted on CNS for the southeastern beach mouse (Ref. 25 and 26). No mice were found on Playalinda Beach, which has been open to the public for many years. In 1991, vehicle access from Playalinda Beach Road south to the KSC boundary was stopped, so public visitation to that end of the beach dropped considerably. In 2000, a presence and absence survey duplicating the methods of Stiner (Ref. 25 and 26) was done and beach mice were documented at the site (Ref. 27). Animals likely immigrated onto the Playalinda Beach dune from the adjacent KSC dune and were able to reestablish a population in absence of human pressure.

Live trapping for Florida mice was conducted four times between July 2001 and July 2002 at Happy Creek. Trapping grids were set in scrub habitat that was interspersed with shallow freshwater swale marshes. The July 2001 sample period consisted of six consecutive nights and the remaining sample periods consisted of two consecutive nights each. There were 24 captures of 17 individual Florida mice. Eight were males and nine were females. Twelve were adults and five were juveniles. This information starts a database that will eventually be compared to data collected in the 1970s.

In 1977, KSC supported inventory actions by the USFWS in their endeavors to determine the abundance and distribution of the endangered manatee throughout Florida including the NASA/KSC property. The surveys indicated that a large number of manatees were utilizing the same body of water that NASA intended to use for Space operations. As much as 15 percent of the total manatee population of the U.S. is located within the waters immediately surrounding KSC property (Ref. 28). It became clear that the National Environmental Policy Act (NEPA) and compliance with Endangered Species Act would best be met through monitoring of this endangered species and its habitat. Monitoring the distribution and abundance manatees at KSC has been primarily performed through aerial surveys that have been funded by KSC intermittently from 1977- 1983 and almost continuously since 1984 (Ref. 29). Since 1991, KSC aerial surveys have been conducted during cold periods in conjunction with the FFWCC's population census referred to as the Statewide Synoptic Survey. The data collected are immediately shared with the FFWCC. The data have been shared with various agencies and universities, presented at scientific meetings, and published in peer-reviewed journals. The raw 1977-1990 aerial survey data were made available to the public on a CD-ROM in a joint venture with the Florida Fish and Wildlife Conservation Commission through the Manatee GIS Working Group. KSC has maintained a position on the Manatee GIS Working Group since its inception. Data sets have been shared with FFWCC on many occasions over the years and more recent data were submitted (with restricted use) to FFWCC for their evaluation of speed zone regulations currently being developed. Data have also been shared with the "public" through invited presentations to environmental, educational, marine industry groups, the Brevard County Commission, Marine Mammal Commission, and the US Army Corps of Engineers (US COE).

In 1990, to further protect this endangered species, the USFWS created a sanctuary for manatees covering the majority of the KSC section of the Banana River. The USFWS officially designated the following areas at KSC as Critical Habitat: (1) the entire inland section of water known as the Indian River, from its northernmost point immediately south of the intersection of U.S. Highway 1 and Florida State Road 3; (2) the entire inland section of water known as the Banana River, north of KARS Park; (3) and all waterways between the Indian and Banana Rivers (exclusive of those existing manmade structures or settlements, which are not necessary to the normal needs of survival of the species). Critical habitat and areas of manatee concentration are shown in Figure 7-3. KSC biologists also participate in the manatee-stranding network for which dead and live standings are reported to FFWCC and USFWS agencies. Those agencies collect the animals, rehabilitate or file necropsy reports. Those data are maintained and archived by FFWCC.

7.5 REFERENCES

1. Brice, John J. 1898. The Fish and Fisheries of the Coastal Waters of Florida. Rep. to the U.S. Commiss. of Fish and Fisheries. 22:263-342.

2. Wilcox, W.A. 1898. Commercial fisheries of the Indian River, Florida. Report to the U.S. Commission of Fish and Fisheries 22:249-269.

3. Ehrhart, L.M. 1976. A study of a diverse coastal ecosystem of the Atlantic coast of Florida. Final Report to NASA, # NAS10-8986, NASA Biomedical Operations and Research Office, Kennedy Space Center, Florida. 182 pp.

4. Ehrhart, L.M. and Redfoot, W.E. 1992. Trends in Loggerhead and Green Turtle Population Densites in Florida's East Coast Lagoons: The Usefulness of CPUE Analysis. Florida Scientist 55:25.

5. Ehrhart, L.M. 1983. Marine Turtles of the Indian River Lagoon System. Florida Scientist. 46: 337-346.

6. Witherington, B.E. and Ehrhart, L.M. 1989. Hypothermic Stunning and Mortality of Marine Turtles in the Indian River Lagoon System, Florida. Copeia 1989(3):696-703.

7. Breininger, D.R., P.A. Schmalzer, D.A. Rydene, and C.R. Hinkle. 1988. Burrow and habitat relationships of the gopher tortoise in coastal scrub and slash pine flatwoods on Merritt Island, Florida. Florida Game and Fresh Water Fish Commission, Nongame Wildlife Program Final Report, 238 pp.

8. Smith, R.B., D.R. Breininger, and V.L. Larson. 1997. Home range characteristics of radiotagged gopher tortoises on Kennedy Space Center, Florida. Chelonian Conservation and Biology 23:358-362.

9. Smith, R.B., R.A. Seigel, and K.R. Smith. 1998. Occurrence of upper respiratory tract disease in gopher tortoise populations in Florida and Mississippi. Journal of Herpetology 32:426-430.

10. Seigel, R.A., R.B. Smith, and N.A. Seigel. 2003. Swine flu or 1918 pandemic? Upper respriatory tract disease and the sudden mortality of gopher tortoises (*Gopherus polyphemus*) on a protected habitat in Florida. Journal of Herpetology 37:137-144.

11. Breininger, D. R., M. L. Legare, and R. B. Smith. In press. Edge effects and population viability of Eastern Indigo Snakes. Pages 000-000 in H. R. Akçakaya, M. Burgman, O Kindvall, P. Sjorgren-Gulve, J. Hatfield, and M. McCarthy, editors. Species conservation and management: case studies. Oxford University Press.

12. Smith, R.B. and D.R. Breininger. 1995. Wading bird populations of Kennedy Space Center. Bulletin of Marine Science 57:230-236.

13. Smith, R.B. and D.R. Breininger. 1988. Northern breeding range extension for the roseate spoonbill in Florida. Florida Field Naturalist 16:65-67.

14. Breininger, D. R. 2003. Biological criteria for the recovery of Florida scrub-jay on public lands in Brevard County and Indian River County. Final report to U.S. Fish and Wildlife Service, Endangered Species Office, Jacksonville, Florida.

15. Breininger, D.R., V.L. Larson, R. Schaub, B.W. Duncan, P.A. Schmalzer, D.M. Oddy, R.B. Smith, F. Adrian, and H. Hill, Jr. 1996a. A conservation strategy for the Florida Scrub-Jay on John F. Kennedy Space Center/Merritt Island National Wildlife Refuge: an initial scientific basis for recovery. NASA Technical Memorandum 111676. Kennedy Space Center, Florida. 113 pp.

16. Breininger D. R., V. L. Larson, B. W. Duncan, and R. B. Smith. 1998. Linking habitat suitability to demographic success in Florida Scrub-Jays. Wildlife Society Bulletin 26:118-129.

17. Breininger, D. R., M. A. Burgman, and B. M. Stith. 1999. Influence of habitat quality, catastrophes, and population size on extinction risk of the Florida Scrub-Jay. Wildlife Society Bulletin 27:810-822.

18. Breininger, D.R., V.L. Larson, B.W. Duncan, R.B. Smith, D.M. Oddy, and M.F. Goodchild. 1995. Landscape patterns of Florida scrub jay habitat use and demographic success. Conservation Biology 9:1442-1453.

19. Dreschel, T.W., R.B. Smith, and D.R. Breininger. 1990. Florida scrub jay mortality on roadsides. Florida Field Naturalist 18: 82-83.

20. Breininger, D.R., V.L. Larson, D.M. Oddy, R. B. Smith, and M.J. Barkaszi. 1996b. Florida Scrub Jay demography in different landscapes. Auk 113:617-625.

21. Burgman, M. A., D. R. Breininger, B. W. Duncan, and S. Ferson. 2001. Setting reliability bounds on habitat suitability indices. Ecological Applications 11:70-78.

22. Breininger, D. R. and D. M. Oddy. 2001. Fire and Florida Scrub-Jay source-sink dynamics in mesic flatwoods. Pages 3-7 *in* D.P. Zattau (editor), Proceedings of the Florida Scrub Symposium 2001. U.S. Fish and Wildlife Service, Jacksonville, Florida.

23. Breininger D.R., B.W. Duncan, and N.J. Dominy. 2002. Relationships between fire frequency and vegetation type in pine flatwoods of East-Central Florida, USA. Natural Areas Journal 22:186-193.

24. Breininger, D. R., and G. C. Carter. 2003. Territory quality transitions and source-sink dynamics in a Florida Scrub-Jay population. Ecological Applications 13: 516-529.

25. Stiner, J.C. 1991. Survey of the threatened southeastern beach mouse (*Peromyscus polionotus niveiventris*) at Canaveral National Seashore, Florida. Report to the National Park Service.

26. Stiner, J.C. 1992. Supplemental survey of the threatened southeastern beach mouse (*Peromyscus polionotus niveiventris*) at Canaveral National Seashore, Florida. Report to the National Park Service.

27. Mota, M., J. Weidlich, and J. Stiner. 2001. Population status of beach mice, *Peromyscus polionotus niveiventris*, in the southernmost portion of Canaveral National Seashore, Florida. Published abstract, Program Issue, Florida Academy of Sciences 65th Annual Meeting, St. Leo University.

28. Hall, C.R., Breininger, D.R., Schamlzer, P.A., Drese, J.H., Provancha, M.J., Provancha, J.A. and Dreschel, T.W. 1986. Polygeneration Project Baseline Environmental Monitoring Program: Final Report. NASA/KSC Biomedical Office. John F. Kennedy Space Center, Florida.

29. U.S. Fish and Wildlife Service. 1990. Annual Narrative Report Calendar Year 1989. U.S. Department of Interior Fish and Wildlife Service National Wildlife System. Merritt Island National Wildlife Refuge, Merritt Island, Florida.

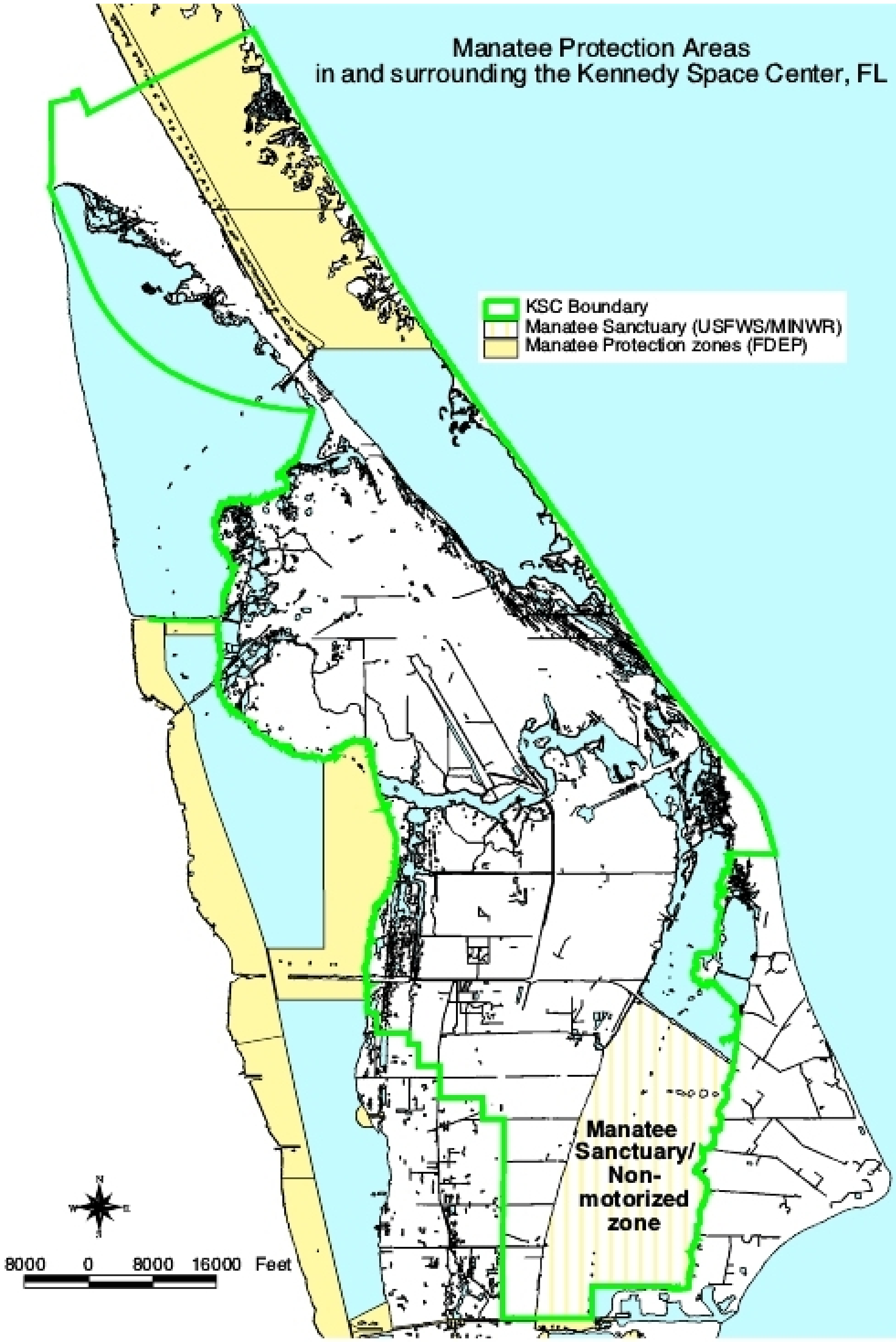

Figure 7-3. Manatee Zones Associated with KSC.

SECTION VIII

HAZARDOUS AND SOLID MATERIALS AND WASTES

8.1 INTRODUCTION

8.1.1 REGULATORY OVERVIEW - FEDERAL

Federal statutes have been promulgated that address hazardous materials, hazardous wastes, potential impacts to the environment and handling from manufacture to disposal. These Federal statutes are administered by a variety of Government agencies that specifically address the generation, handling, transport, and proper disposal of hazardous materials and wastes, that are most applicable to activities at KSC are outlined in Table 8-1 below.

Table 8-1. Federal Statues Governing Toxic Wastes and Substances.

Statute	U.S. Code
Comprehension Environmental Response, Compensation, and Liability Act	42 U.S.C. 9601
Resource Conservation and Recovery Act	42 U.S.C. 6901
Toxic Substances Control Act	15 U.S.C. 2601
Clean Water Act	33 U.S.C. 1251
Clean Air Act	42 U.S.C. 7401
Safe Drinking Water Act	42 U.S.C. 300(f)
Federal Insecticide, Fungicide, and Rodenticide Act	7 U.S.C. 136
Occupational Safety and Health Act	29 U.S.C. 651
Hazardous Materials Transportation Act	49 U.S.C. 1801

8.1.1.1 Pesticides. Pesticides, which are chemical or biological substances used to control undesirable plants, insects, fungi, rodents or bacteria, can be extremely toxic and can cause serious harm if spilled on the skin, inhaled, or otherwise misused. The Environmental Protection Agency (EPA) regulates pesticides under two laws: (1) the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and (2) the Pesticide Amendment to the Federal Food, Drug, and Cosmetic Act (FFDCA).

8.1.1.2 Radiation

8.1.1.2.1 Ionizing Radiation. Ionizing radiation can be a source of environmental contamination. Sources of this form of radiation include uranium mining and milling, nuclear power wastes, and radioactive materials used in medicine. The health effects of non-ionizing radiation, such as microwaves and radiation from high voltage power lines, are not as well understood, but they, too, are considered potentially hazardous.

A number of Federal agencies, including EPA, are responsible for regulating emissions of ionizing radiation. EPA derives its ionizing radiation regulations from the Atomic Energy Act of 1954, the Public Health Service Act of 1962, the Safe Drinking Water Act of 1974, the Clean Air

Act Amendments of 1977, the Uranium Mill Tailings Radiation Control Act of 1978, the Marine Protection and Sanctuaries Act, the Clean Water Act, the Nuclear Waste Policy Act of 1982, and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. The Agency's major responsibilities are to set radiation guidelines, assess new technology, and monitor radiation in the environment.

8.1.1.2.2 Non-ionizing Radiation. FDEP is presently developing a rule setting requirements to reasonably protect the public health, safety, and welfare from electric and magnetic fields of future electric transmission lines.

8.1.1.3 Toxic Substances Control Act. Toxic substances include a number of manufactured chemicals, as well as naturally occurring heavy metals and other materials. In 1976, Congress passed the Toxic Substances Control Act (TSCA) to regulate contaminants such as polychlorinated biphenyls (PCB's), dioxin, and asbestos introduced in the environment. TSCA requires EPA to develop and keep current a comprehensive chemical inventory, which presents an overall picture of the chemicals used for commercial purposes in the U.S. TSCA is applicable only to chemicals in commercial use and not those used for research and development.

8.1.1.4 Resource Conservation and Recovery Act (RCRA) - Waste Management. In 1965, Congress passed the Solid Waste Disposal Act. It was replaced in 1976, when Congress enacted the Resource Conservation and Recovery Act (RCRA), which authorized EPA to regulate current and future waste management and disposal practices. In 1984, the Hazardous and Solid Waste Amendments (HSWA) to the RCRA were enacted (reference Section 8.1.3.1).

8.1.1.5 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The Act Authorizes EPA to respond to a danger that may pose a threat to public health or the environment as a result of abandoned hazardous waste disposal sites, improperly operated industries or catastrophic spillage of hazardous materials. The agency is also authorized to take long-term remedial actions to achieve a permanent cleanup of these (hazardous waste) sites.

8.1.1.6 Hazardous Materials Transportation Act (HMTA). EPA is required by RCRA to be consistent with the Department of Transportation (DOT) under HMTA. To meet this mandate, EPA has incorporated the DOT regulations, which are outlined in 40 CFR Parts 170-179, assuring consistency of coverage under the two programs. Generally, DOT covers the packaging, labeling, and proper identification of hazardous materials in accordance with the DOT Hazardous Materials Table. EPA and DOT issued a joint Memorandum of Understanding (MOU) delineating their respective enforcement and compliance responsibilities. EPA monitors compliance by hazardous waste generators and treatment, storage, and disposal facilities, while DOT conducts inspections and applies RCRA standards to transporters. Unlike many of the DOT transportation regulations, these apply to both interstate and intrastate transport of hazardous waste.

8.1.1.7 Priority Pollutants and Hazardous Constituents. The result of the Clean Water Act (CWA) and many of those acts mentioned above has been the establishment of effluent standards and the regulation of toxic substances released to the Nation's surface and ground waters. In 1976, a Consent Decree required EPA to establish a list of specific pollutants and their effluent limitations. A primary listing was initiated with additional compounds being added after screening water supplies. This procedure resulted in the so-called "priority pollutant" list outlined in Table 8-2. The 125 priority pollutants represent the subset of EPA's Hazardous Constituent List (40 CFR Part 261), which is most likely to impact water quality. EPA criteria documents for a number of priority pollutants are available and listed in Table 8-3. Required methods for analyzing these pollutants are specified in 40 CFR Part 136.

8.1.1.8 Storage Facility Standards. EPA does not allow temporary storage of hazardous waste in surface impoundments or land storage facilities. All hazardous wastes must be stored in appropriately labeled containers and tanks while at temporary storage areas.

8.1.1.9 90-Day Storage Provision. 40 CFR 262.34 allows for the accumulation of hazardous waste on-site for a period of up to 90 days without obtaining a permit. Additionally, generators can accumulate hazardous waste at staging areas before removing the material to a central storage facility. Up to 208 liters (55 gallons) of hazardous waste, or 1 quart of acutely hazardous waste (40 CFR 261.33(e)), may be accumulated at or near any point of generation, which is under control of the operator of the process. In the case of multiple waste streams generated at the same point of generation from the same process under control of the same operator, 208 liters (55 gallons) of hazardous waste (or 1 quart of acutely hazardous waste) may be accumulated for each waste stream. This is the FDEP Central District interpretation of 40 CFR 262.34 (c)(1).

8.1.1.10 Non-Hazardous Wastes. - Federal regulatory authority of solid wastes is contained in 40 CFR, EPA, Subchapter I - Solid Waste. Federal solid waste regulations address land disposal, incineration, the storage and collection of residential, commercial, and institutional wastes, and establish criteria for solid waste disposal facilities and practices. EPA has the primary authority to enforce Federal solid waste regulations.

The Solid Waste Disposal Act as amended by RCRA 1976, provides for Federal assistance to the states for the purpose of developing solid waste management plans. These plans were to provide for the environmentally sound management and disposal of solid hazardous waste, encourage resource conservation, and maximize the utilization of valuable resources.

8.1.2 REGULATORY OVERVIEW - STATE

8.1.2.1 Hazardous Waste Permitting. EPA has delegated hazardous waste permitting to the State. Permitting programs are in place for hazardous waste disposal, storage and treatment facilities. RCRA P.L. 94-580 and parallel State-permitting criteria contained in Chapter 403 F.S. and Chapter 62-730, F.A.C. established Federal hazardous waste regulatory programs. EPA still retains overview authority and certain permitting functions.

The Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA) were enacted into law on November 8, 1984. One of the major provisions (Section 3004(u)) of these amendments requires corrective action for releases of hazardous waste or constituents from solid waste management units (SWMUs) at hazardous waste treatment, storage or disposal facilities. Under this provision, any facility that has a RCRA hazardous waste management facility permit will be subject to a RCRA Facility Assessment (RFA).

8.1.2.2 Transporting Hazardous Waste. Vehicles, which transport hazardous waste, are subject to U.S. DOT requirements of 49 CFR Parts 171-178, which Florida DOT has adopted and incorporated by reference in Section 316.302, F.S. Similarly, FDEP has adopted the Federal hazardous waste transporter regulations in 40 CFR Part 263 by reference in Chapter 62-730, F.A.C.

8.1.2.3 Non-Hazardous Wastes. The State of Florida recognized the need to regulate and manage solid wastes and consequently enacted the Florida Resource and Recovery Act of 1974. The Act provides for the planning and regulation of the storage, collection, transportation, separation, processing, recycling, and disposal of solid wastes. FDEP was authorized to administer the Act and was delegated the authority to adopt a State Resource Recovery and Management Program. FDEP provides technical assistance to local Governments for the development of resource recovery programs, issues permits for resource recovery and solid waste treatment and disposal facilities, and prescribes the conditions under which these facilities operate. Rules governing the permitting and operation of Solid Waste Management Facilities are contained in F.A.C. Chapter 62-701.

To ensure compliance with the appropriate Federal and State regulatory programs and to further assure that solid waste disposal does not adversely impact public health or environmental quality at KSC, NASA has issued directives on the operation and maintenance of solid waste disposal facilities. A summary of the State, Federal, and NASA regulatory programs and directives on the management of solid waste facilities is as follows.

8.2 KSC HAZARDOUS WASTE MANAGEMENT PROGRAM

8.2.1 KSC HAZARDOUS WASTE MANAGEMENT ORGANIZATION

NASA has developed a program of managing and handling hazardous and controlled wastes at KSC in compliance with the provisions of the RCRA of 1976 and the implementing regulations adopted by the State of Florida (62-730, F.A.C.). The organizational and procedural requirements of the KSC hazardous waste management program are contained in KHB 8800.7, "Waste Management Handbook". This handbook and supporting documents clearly delineate the procedures and methods to obtain and provide hazardous waste support, establish and approve operations and maintenance instructions, and provide instructions to maximize resource recovery and minimize costs (see Table 8-4). Additionally, the Center utilizes the Joint Base Operations Support Contract (JBOSC) in providing contractor support for the management and storage of waste to be disposed of off-site from the Center’s permitted Treatment Storage and Disposal Facility (TSDF). Contractor support includes the development of waste specific management guidance that is provided to the Center’s waste generators to assist in managing the waste for off-site disposal. The support contractor directs and documents relevant actions associated with hazardous and controlled waste handling, including sampling, storage, transportation, treatment, disposal and recovery to ensure compliance with all applicable Federal, State, and local regulations.

Table 8-2. Organic Toxic Pollutants in Each of Four Fractions in Analysis by Gas Chromatography/Mass Spectroscopy (GC/MS).

Volatiles	**Base/Neutral (continued)**
Acrolein	2,6-dinitrotoluene
Acrylonitrile	di-n-ocyl phthalate
Benzene	1,2-diphenylhydrazine (as azobenzene)
Bromoform	Fluoranthene
Carbon tetrachloride	Fluorine
Chlorobenzene	Hexachlorobenzene
Chlorodibromomethane	Hexachlorobutadiene
Chloroethane	Hexachlorocyclopentadiene
2-chloroetylvinyl ether	Hexachloroethane
Chloroform	Indeno (1,2,3-cd) pyrene
Dichlorobromomethane	Isophorone
1,1-dichloroethane	Naphthalene
1,2-dichloroethane	Nitrobenzene
1,1-dichloroethylene	N-nitrosodimethylamine
1,2-dichloropropane	N-nitrosodi-n-propylamine
1,3-dichloropropylene	N-nitrosodiphenylamine
Ethylbenzene	Phenanthrene
Methyl bromide	Pyrene
Methyl chloride	1,2,4-trichlorobenzene
Methylene chloride	4,4'-DDD
1,1,2,2-tetrachloroethane	Dieldrin
Tetrachloroethylene	**Pesticides**
Toluene	Aldrin
1,2-trans-dichloroethylene	Alpha-BHC
1,1,1-trichloroethane	Beta-BHC
1,1,2-trichloroethane	Anthracene
Trichloroethylene	Benzidine
Vinyl chloride	Benzo (a) anthracene
Acid Compounds	Benzo (a) phyrene
2-Chlorophenol	4,4'-DDE
2,4-Dichlorophenol	Alpha-endosulfan
2,-Dimethylphenol	Beta-endosulfan
4,6-Dinitro-O-Cresol	Endosulfan sulfate
2,4-Dinitrophenol	Endrin
2-Nitrophenol	Endrin aldehyde
4-Nitrophenol	Heptachlor
P-Chloro-M-Cresol	Heptachlor epoxide
Pentachlorophenol	PCB-1242
Phenol	PCB-1254
2,4,5-trichlorophenol	PCB-1221
Base/Neutral	PCB-1232
Acenaphthene	PCB-1248
Acenaphthylene	PCB-1260
3, 4-benzolfluoranthene	PCB-1016
Benzo (ghi) perylene	Toxaphene
Benzo (k) fluoranthene	**Metals, Cyanide and Total Phenols**
Bis (2-chloroethoxy) methane	Gamma-BHC
Bis (2-chlorethyl) ether	Delta-BHC
Bis (2-chloroisprophyl) ether	Chlordane
Bis (2-ethylhexyl) phthalate	4,4'-DDT
4-bromophenyl phenyl ether	Antimony, Total
Butylbenzyl phthalate	Arsenic, Total
2-chloronaphthalene	Beryllium, Total
4-chlorophenyl phenyl ether	Cadmium, Total
Chrysene	Chromium, Total
Dibenzo (a,h) anthracene	Copper, Total
1,2-dichlorobenzene	Lead, Total
1,3-dichlorobenzene	Mercury, Total
1,4-dichlorobenzene	Nickel, Total
3,3'-dichlorobenzidine	Selenium, Total
Diethyl phthalate	Silver, Total
Dimethyl phthalate	Thallium, Total
di-n-butyl phthalate	Cyanide, Total
2,4-dinitrotoluene	Phenols, Total

Table 8-3. EPA Water Quality Criteria Publications.

1	Acenaphthalene	PB81-117269	**33**	Endosulfan	PB81-117657
2	Acrolein	PB81-117277	**34**	Endrin	PB81-117665
3	Acrylonitrile	PB81-117285	**35**	Ethylbenzene	PB81-117673
4	Aldrin/dieldrin	PB81-117301	**36**	Fluoranthene	PB81-117681
5	Antominy	PB81-117319	**37**	Haloethers	PB81-117699
6	Arsenic	PB81-117327	**38**	Halomethanes	PB81-117707
7	Asbestos	PB81-117335	**39**	Heptachlor	PB81-117632
8	Benzene	PB81-117293	**40**	Hexachlorobutadine	PB81-117640
9	Benzidine	PB81-117343	**41**	Hexachlorocyclohexane	PB81-117657
10	Beryllium	PB81-117350	**42**	Hexachlorocyclopentadine	PB81-117665
11	Cadmium	PB81-117368	**43**	Isophorone	PB81-117673
12	Carbon Tetrachloride	PB81-117376	**44**	Lead	PB81-117681
13	Chlordane	PB81-117384	**45**	Mercury	PB81-117769
14	Chlorinated benzenes	PB81-117392	**46**	Naphthalene	PB81-117707
15	Chloroalkyl ethanes	PB81-117400	**47**	Nickel	PB81-117715
16	Chlorinated ethers	PB81-117418	**48**	Nitrobenzene	PB81-177723
17	Chlorinated naphthalene	PB81-117426	**49**	Nitrophenols	PB81-117749
18	Chlorinated phenols	PB81-117434	**50**	Nitrosamines	PB81-117756
19	Chloroform	PB81-117442	**51**	Pentachlorophenol	PB81-117764
20	2-Chlorophenol	PB81-117459	**52**	Phenol	PB81-117772
21	Chromium	PB81-117467	**53**	Phthalate esters	PB81-117780
22	Copper	PB81-117475	**54**	Polychlorinated biphenyl	PB81-117798
23	Cyanides	PB81-117483	**55**	Polynuclear aromatic hyd	PB81-117806
24	DDT	PB81-117491	**56**	Selenium	PB81-117814
25	Dichlorobenzenes	PB81-117509	**57**	Silver	PB81-117822
26	Dichlorobenzidine	PB81-117517	**58**	Tetrachloroethylene	PB81-117830
27	Dichloroethylenes	PB81-117525	**59**	Thallium	PB81-117848
28	2,4-Dichlorophenol	PB81-117533	**60**	Toluene	PB81-117855
29	Propanes/propenes	PB81-117541	**61**	Toxaphene	PB81-117863
30	2,4-Dimethylphenol	PB81-117558	**62**	Trichloroethylene	PB81-117871
31	Dinitrotbluene	PB81-117566	**63**	Vinyl chloride	PB81-117889
32	Diphenylhdrazine	PB81-117731	**64**	Zinc	PB81-117897

Table 8-4. NASA Hazardous Waste Management Directives.

KHB 8800.7	Hazardous Waste Management
KMI 8800.8	Kennedy Space Center Environmental Management
KHB 1200.1	Facilities, Systems, and Equipment Management Handbook
KHB 1710.2	Kennedy Space Center Safety Practices Handbook
KHB 1840	Industrial Hygiene Handbook
KHB 4000.1	Supply Support System Manual
KHB 5310.1	Reliability Maintainability and Quality Assurance Handbook
KSC Plan	Spill Prevention, Control, and Countermeasures (SPCC) Plan

The Center’s hazardous and non-RCRA regulated waste generation activities are dependent to launch processing, construction, and associated activities. EO 13148 mandates the hazardous waste reduction goal for KSC, excluding waste generated from remediation activities. The goal is to reduce the waste generated by 10 percent (by weight) based on the previous calendar year (CY) goal. KSC achieved the CY 2002 waste minimization goal of 207.6 metric tons.

The Center's (JBOSC) provided contractor support has two internal groups that furnish information for the management and storage of waste for off-site disposal. The Evaluation and Planning group provides information to the waste generator on the proper way to containerize and label the waste being stored for disposal. The Waste Operations group provides waste pick-up and transportation to the Center's waste generators for long-term storage at the TSDF and eventually off-site disposal. In addition, Waste Operations provides other services such as bulk accumulation of used oil and industrial wastewater, including material generated in association with post-spill clean-up activities. The number of hazardous waste collection sites maintained at the Center is dynamic. The contractors are continually reviewing processes to reduce the amount of hazardous waste being generated; this reduces the number of sites required to manage the waste. This waste reduction and minimization effort are also associated with the requirements of EO 13148.

8.2.2 KSC HAZARDOUS WASTE OPERATING PERMITS

KSC has an FDEP operating permit for the storage, treatment, and disposal of hazardous waste. The main facilities operating under this permit are the Hazardous Waste Storage Facility (K7-165) in the LC-39 Area, which handles liquid and solid hazardous wastes. There are four cells at the facility each of which is designated and designed for the storage of specific hazardous wastes. Wastes permitted to be stored at the facility include the following: flammable, organic, and toxic waste; caustic toxic reactive wastes; acidic waste; and solid hazardous and controlled wastes. Waste Operations operates the facility and maintains records and reports associated with waste activities at the facility to ensure Center compliance.

8.2.3 HAZARDOUS AND CONTROLLED WASTE GENERATION

KSC maintains a comprehensive inventory of all RCRA defined hazardous wastes and controlled waste not regulated by RCRA. This inventory is maintained by a manifest records system, which tracks the generation, on-site storage, treatment, and reclamation of hazardous and controlled wastes. Various types of waste being managed include used oil, which is recycled, used antifreeze, which is recycled, and fluorescent lamps, that are managed as universal waste and are also recycled. The manifest records system is integrated with an automated data processing system, which provides the capability to generate current waste status reports, as well as, quarterly and annual summary reports. The JBOSC contractor is responsible for the maintenance of the hazardous and controlled waste database inventory, including the KSC Biennial Hazardous Waste Disposal Report**.**

8.2.3.1 Waste Minimization. As a part of the Waste Management Program, KSC is implementing waste minimization alternatives to the Center's operations, as directed by NASA Headquarters and in accordance with EO 13148. The Center's waste management initiative is to reduce releases and off-site transfers of toxic chemicals for treatment and disposal. This will be accomplished through source control, recycling, recovery and reuse, as well as alternatives for treating the wastes. Examples of materials targeted for minimization include freon 113, lead, tetrachloroethylene, and methyl hydrazine.

Two examples of waste reduction through source control and alternative treatment involved tetrachloroethylene and methyl hydrazine. Tetrachloroethylene was a key ingredient in the composition of a two-part paint used in Space Shuttle activities, as well as a cleaning agent, that produced large amounts of hazardous material and waste at the Center. The paint was reformulated to eliminate tetrachloroethylene and alternative cleaning agents have been approved for use in association with Shuttle processing, thus eliminating use through source control. Another waste reduction was accomplished through alternative treatment of methyl hydrazine by UV exposure to produce oxidation. As a result, the waste material can now be discharged to the Center's sewer system.

8.2.3.2 KSC/Schwartz Road Class III Operational Landfill - The KSC/Schwartz Road Class III Landfill is located in the restricted access area at the Kennedy Space Center on Merritt Island, southeast quarter of Section 20, Township 22 South, and Range 37 East. The landfill is located at 28 degrees 33' 30" North and Longitude 80 degrees 38' 36" West. The site is located adjacent to and to the east of the closed Schwartz Road Landfill, directly south of Schwartz Road and approximately 2.2 km (1.4 mi) east of Kennedy Parkway. Construction began in August 1994, with completion prior to closure of the Schwartz Road Landfill in January 1996. The facility is expected to handle the solid waste disposal needs of KSC for an estimated 13 to 49 years, based on assumed disposal rate scenarios of 350 tons per week (13 years) and 90 tons per week (49 years).

The permitted Class III landfill is unlined and does not accept putrescible household waste. NASA contractor personnel, who are trained in accordance to FDEP and Federal regulatory requirements, operate the landfill. Operating Reports are generated and forwarded to the State on a quarterly basis consisting of daily wastes received by weight. These wastes consist of construction, demolition and maintenance debris, sandblast media, unserviceable furniture, wood and plastic products and yard waste. The landfill is permitted to take asbestos, but currently at this time we do not accept any asbestos containing materials. Logbooks are maintained at the scale house for incoming wastes documenting the transporters, contractor and debris being placed into the landfill. The working face of the landfill is monitored by trained spotters to protect against unauthorized waste, conducts the load-checking program and traffic control as required by FDEP. The weekly cell construction is built from the refuse deposited on a daily basis and compacted. The cell has to be a minimum of 1.9 m (6.5 ft) thick across the row to conform to requirements. The first row is constructed east to west and the next row will be west to east alternating on each row. Initial cover to minimize the adverse environmental health hazards resulting from birds, animals, waste, blowing liter and fires is applied 15 cm (6 in) (minimum) thick compacted on a weekly basis. Inactive areas of 180 days or more will receive additional cover of 30 cm (12 in). Stormwater control is routed to the perimeter drainage ditches that surround the landfill. The stormwater ditches, culverts and wet detention pond are designed to convey, retain, and discharge all stormwater runoff from a 25 year, 24-hour duration storm event.

The landfill has a Groundwater Monitoring Plan, with a well field consisting of 32 wells, 2 surface water sample points, and 4 additional monitoring wells to be installed during the life cycle of the landfill. Regulatory groundwater monitoring reporting requirements are met on semi-annual and bi-annual schedule. The Gas Monitoring Plan requires quarterly reporting on a field of 16 monitoring wells. All water and gas sample analysis is performed by a State certified laboratory and forwarded to the NASA Environmental Program Branch for review prior to submittal to FDEP.

8.3 SOLID WASTE

8.3.1 Schwartz Road Class III Closed Landfill - The Schwartz Road Closed Landfill was the primary land disposal site at KSC until December 1995. The landfill was placed in operation in 1968, and operated initially as a Class II facility until 1982. Since 1982, the landfill has accepted only Class III waste material, which included trash and paper products, plastic, glass, and debris as a result of land clearing, construction, or demolition activities. The landfill site encompasses approximately 25 ha (64 ac), with about 20 ha (51 ac) being utilized for waste disposal. Renewal of the facility operations permit in March 1993 resulted in completion of a site-specific hydrogeologic investigation and in the construction of a new network of groundwater monitoring wells.

Waste disposal consisted of excavated cells to depths of 0.9 to 1.8 m (3 to 6 ft) below original grade, with cell dimensions being roughly 15 m (50 ft) in width and 106 m (350 ft) in length. Trenching began along the east side of the site and progressed westward, with trenches generally oriented in the east and west directions. The closed trenches have been covered with approximately 0.6 m (2 ft) of sandy soil. Final closure of the Schwartz Road Landfill was in January 1996. Long-term site closure monitoring will continue for 30 years from the date of closure.

SECTION IX

KSC STORAGE TANK SYSTEMS MANAGEMENT PROGRAM UNDERGROUND STORAGE TANKS (UST), ABOVEGROUND STORAGE TANKS (AST) AND HAZARDOUS WASTE TANKS

9.1 REGULATORY OVERVIEW

Storage tanks systems can be aboveground (ASTs) or underground (USTs). A tank system includes the storage or treatment tank and its associated ancillary equipment and containment system. The regulations define an AST as a tank situated in such a way that its entire surface area (including the bottom) is above the plane of the adjacent surrounding surface and can be visually inspected and for UST's as a tank with 10 percent of their volume underground (including connective piping).

9.1.1. UNDERGROUND STORAGE TANKS

In 1984, Congress added Subtitle I to the Resource Conservation and Recovery Act (RCRA), establishing a comprehensive regulatory program for USTs containing regulated substances. EPA regulates this program under Title 40 CFR (Code of Federal Regulations) Part 280. In addition to the Federal regulation, many states have enacted UST regulations.

For more than 50 years, USTs have been widely used throughout the nation to store petroleum products, chemicals, and wastes. Most of these tanks contain petroleum products such as gasoline, diesel or oil. The State of Florida regulates the UST program under F.A.C. (Florida Administrative Code) Part 761. Specific requirements vary depending on the contents of tanks. Generally, tanks must meet specific installation standards and requirements for corrosion protection, spill/overfill prevention, and leak detection.

9.1.2 ABOVEGROUND STORAGE TANKS

Aboveground systems incorporate the National Fire Protection Association standards (NFPA-30), and for oil and used oil tanks, Title 40 CFR Part 112, Spill Prevention, Control and Countermeasure Plan (SPCC). The State of Florida regulates the AST program under F.A.C. Part 761. Specific requirements vary depending on the contents of tanks. Generally, tanks must meet specific installation standards and requirements for corrosion protection, spill/overfill prevention, and leak detection.

9.1.3 HAZARDOUS WASTE TANKS

Subtitle C of RCRA establishes requirements for managing hazardous wastes. The requirements for tank systems storing hazardous wastes are detailed in Title 40 CFR Parts 264, Subpart J and 265, Subpart J. The regulations for these tank systems apply to both underground and aboveground hazardous waste tank systems. The Florida Department of Environmental

Protection's Central District is the local administering agency for the hazardous waste tank regulations affecting KSC.

9.1.4 HAZARDOUS TANK SYSTEMS ON KSC

Table 9-1 lists the existing hazardous tanks systems in operation on KSC:

Table 9-1. Regulated Hazardous Waste Tank Systems for KSC for 2002.

Facility/ Building #	Stored Material	Capacity (gallons)	Construction
Hangar AF/CCAFS 66242	Alcohol (IPA)	225	Stainless Steel
ARF/L6-247	Alcohol (IPA)	225	Stainless Steel
ARF/L6-247	Alcohol (IPA)	225	Stainless Steel

9.2 REGULATED SUBSTANCE TANKS

9.2.1. REGULATORY OVERVIEW

Separate from the hazardous waste tank program and regulations, 40 CFR Part 280 sets forth requirements pursuant to Subtitle I of HSWA for USTs. Tanks regulated under Part 280 contain "regulated substances," which are defined in Section 280.12 to include petroleum products and CERCLA hazardous substances. The primary distinction between the two regulatory sections is based on tank content (hazardous wastes vs. regulated substances). Program requirements for tanks vary significantly between Title 40 CFR Part 264/265 and Part 280. Although both sets of regulations govern tank systems, tanks holding hazardous wastes will be subject to the provisions of RCRA, Title 40 CFR Subtitle C (Parts 264/265).

9.2.2. KSC UNDERGROUND STORAGE TANKS

In the early 1980s, the State of Florida first began addressing the serious threat to groundwater posed by USTs by establishing a rigorous regulatory and remediation program. The State requirements for USTs that contain petroleum products and CERCLA hazardous substances include permitting, construction design, monitoring, record keeping, inspection, accidental releases, financial responsibility, and tank closure. The State program underwent modifications after US/EPA adopted Federal regulations for USTs in late 1988 under the provisions of RCRA. The Brevard County Office of Natural Resources Management is the local administering Agency for the UST regulations affecting KSC.

Various tank removal projects throughout KSC and at KSC-operated and maintained tank systems located on Cape Canaveral Air Force Station (CCAFS) were initiated and performed throughout the mid- to late-1990s with approximately 90 tank systems removed or closed in place. As a result of this project, their remains four underground registered tanks operating on KSC and CCAFS, and all have met the scheduled regulatory upgrades standards for construction, monitoring, leak containment, and operational design. Three tanks have single-wall steel construction and will be required to meet the pending December 2009 regulatory standards for double-walled construction or will be removed and replaced with aboveground tank systems.

Table 9-2 lists the registered underground tank systems in operation on KSC:

Table 9-2. Regulated Underground Storage Tank Systems for KSC for 2002.

Facility/ Building #	Stored Material	Capacity (gallons)	Construction	Year Installed
FSA #1/80700B	Kerosene	2,500	Steel	1990
KSC North/K6-1345	Gasoline	12,000	Steel	1990
M&O/K6-486	Gasoline	8,000	Steel	1990
M&O/K6-486	Diesel	8,000	Steel	1990

9.2.3. KSC ABOVEGROUND STORAGE TANKS

In 1983, Florida was one of the first states to pass legislation, adopt rules, and develop a program for the regulation of aboveground storage tank systems, which store pollutants and have storage capacities of greater than 2081 liters (550 gallons). Tanks regulated under F.A.C. 62-761 include provisions for the tanks integral piping system and its associated release detection. The rule provides standards for the construction, installation, maintenance, registration, removal and disposal of stationary aboveground storage tank systems. This rule implements the requirements of Chapter 376, Florida Statutes.

In Brevard County, FDEP has contracted the annual compliance inspections associated with F.A.C. 17-762 to the Brevard County Office of Natural Resources Management Division (NRMD). The NASA Environmental Program Branch conducts registrations and semi-annual compliance inspections.

Table 9-3 lists the registered aboveground tanks systems in operation on KSC:

Table 9-3. Regulated Aboveground Storage Tank Systems for KSC for 2002.

Facility/ Building #	Stored Material	Capacity (gallons)	Construction	Year Installed
VAB/K6-947	Diesel	30,000	Steel	1965
VAB/K6-947	Diesel	30,000	Steel	1965
VAB/K6-947	Diesel	30,000	Steel	1965
VAB/K6-947	Diesel	10,000	Steel	1966
C5 Substation/K6-1091	Diesel	10,000	Steel	1999
C5 Substation/K6-1091	Diesel	10,000	Steel	1999
S-Band MILA/M5-1444	Diesel	25,000	Steel	1963
HMF Firex/M7-1362	Diesel	1,500	Steel	2000
HMF Firex/M7-1362	Diesel	1,500	Steel	2000
OPF Firex/K6-895	Diesel	1,500	Steel	2002
OPF/Firex/K6-895	Diesel	1,500	Steel	2002
OPF/Firex K6-895	Diesel	1,500	Steel	2002
Pad B Firex/J7-1388	Diesel	1,000	Steel	2000
Pad B Firex/J7-1388	Diesel	1,000	Steel	2000
Pad B Firex/J7-1388	Diesel	1,000	Steel	2000

Table 9-3. Regulated Aboveground Storage Tank Systems for KSC for 2002 (continued).

Facility/Building #	Stored Material	Capacity (gallons)	Construction	Year Installed
Pad B Firex/J7-1388	Diesel	1,000	Steel	2000
Pad B Firex/J7-1388	Diesel	8,000	Steel	2002
VIC/M6-505	Diesel	10,000	Steel	1990
VIC/M6-505	Diesel	10,000	Steel	1990
FSA #1/CCAFS 77615	JP8	20,000	Steel	1955
FSA #1/CCAFS 77616	JP8	20,000	Steel	1955
FSA #1/CCAFS 77617	JP8	20,000	Steel	1955
FSA #1/CCAFS 77618	RP-1	20,000	Steel	1958
FSA #1/CCAFS 77619	RP-1	20,000	Steel	1958
FSA #1/CCAFS 77618	Used Oil	10,000	Steel	1990

SECTION X

REMEDIATION

10.1 REGULATORY OVERVIEW - STATE

10.1.1 HAZARDOUS WASTE PERMITTING

EPA has delegated hazardous waste permitting to the State. Permitting programs are in place for hazardous waste disposal, storage, and treatment facilities. RCRA P.L. 94-580 and parallel State permitting criteria contained in Chapter 403 F.S. and Chapters 62-4, 62-160, 62-520, 62-522, 62-532, 62-550, and 62-730 F.A.C established federal hazardous waste regulatory programs. EPA still retains overview authority and certain permitting functions.

The Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA) were enacted into law on November 8, 1984. One of the major provisions (Section 3004(u)) of these amendments requires corrective action for releases of hazardous waste or constituents from solid waste management units (SWMUs) at hazardous waste treatment, storage, or disposal facilities. Under this provision, any facility that has a RCRA hazardous waste management facility permit will be subject to a RCRA Facility Assessment (RFA).

10.1.2 TRANSPORTING HAZARDOUS WASTE

Vehicles which transport hazardous waste are subject to the U.S. DOT requirements of 49 CFR Parts 171-178, which the Florida DOT has adopted and incorporated by reference in Section 316.302, F.S. Similarly, the FDEP has adopted the Federal hazardous.

10.1.3 SOLID WASTE MANAGEMENT UNITS (SWMUs)

EPA has conducted a RCRA Facility Assessment (RFA) at KSC that was designed to identify SWMUs, which are, or are suspected to be, the source of releases to the environment. For the units identified, KSC was directed to perform a RCRA Facility Investigation (RFI) to obtain information on the nature and extent of the release so that the need for interim corrective measures or a Corrective Measures Study can be determined. Information collected during the RFI can also be used by KSC to aid in formulating and implementing appropriate corrective measures. Such corrective measures may range from stopping the release through the application of a source control technique to a full-scale cleanup of the affected area. In cases where releases are sufficiently characterized, EPA may require KSC to collect specific information needed to implement corrective measures during the RFI.

Since the time of the initial RFA, the list and status of sites has changed significantly. A listing of individual SWMU and Potential Release Location (PRL) sites requiring investigation is found in the HSWA portion of the KSC RCRA facility permit. The list is periodically updated through a permit modification process. Table 10-1 list sites presently on the HSWA permit.

Table 10-1. Solid Waste Management Unit Summary.

Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) Requiring a RCRA Facility Investigation (RFI)	
SWMU/AOC No/Letter	**SWMU/AOC Name**
SWMU#3	Ransom Road Landfill
SWMU#4	Orsino Storage Yard
SWMU#7	Hydrocarbon Burn Facility
SWMU#8	Launch Complex 39A - includes SWMUs 47, 48, 49, 50, and 51
SWMU#9	Launch Complex 39B - includes PRL #46, SWMUs 32, 52, 53, 61, and 62
SWMU#10	General Storage Area Reclamation Yard
SWMU#13	GSA Vehicle Maintenance Facility - includes Battery Acid Dump Site #1
SWMU#32	LC 39B Compressor Building - Part of SWMU 9
SWMU#39	Building M7-505
SWMU#45	Central Heat Plant – includes Cooling Tower Discharge Area, PRL #69
SWMU#46	Pad A Deluge Basin (Tank) – Part of SWMU 8
SWMU#47	Pad A Compressor Building - Part of SWMU 8
SWMU#48	Pad A Fuel Farm - Part of SWMU 8
SWMU#49	Pad A Oxidizer Farm – Part of SWMU 8
SWMU#50	Pad A ECS Site - Part of SWMU 8
SWMU#51	Pad A HVAC Facility - Part of SWMU 8
SWMU#52	Pad B ECS Site - Part of SWMU 9
SWMU#53	Pad B HVAC Facility – Part of SWMU 9
SWMU#56	Mobile Launch Platform Park Sites/Vehicle Assembly Building
SWMU#61	Pad B Fuel Farm - Part of SWMU 9
SWMU#62	Pad B Oxidizer Farm - Part of SWMU 9
SWMU#67	POL Area, M6-894 (formerly PRL #90)
SWMU#70	HMF South Hazardous Waste Staging Area (formerly PRL #94)
SWMU#71	Wilson's Railroad Yard (formerly PRL #91)
SWMU#72	Orbiter Processing Facilities 1 & 2 (formerly PRL #103)
SWMU#73	Roads and Grounds Facility, K6-2096 (formerly PRL #100)
SWMU#74	KSC Press Site, K7-1205 (formerly PRL #102)
SWMU#75	Former Engineering Development Bldg, L5-683, L5-734 (formerly PRL #88)
SWMU#76	Operations and Checkout Bldg (O&C), M7-355, (formerly PRL #110)
SWMU#77	Vertical Processing Facility (VPF), M7-1469, (formerly PRL #109)
SWMU#78	SRB Rotation, Processing, & Storage Facility, K6-345, K6-494, (formerly PRL #104)
SWMU#79	Environmental Health Facility, L7-1557, (formerly PRL #105)
SWMU#80	Former Saturn V Rocket Display, (formerly PRL #101)
SWMU#81	SFOC Generator Maintenance Facility, (former PRL #80)
Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) Requiring No Further Action at this time	
SWMU/AOC No/Letter	**SWMU/AOC Name**
SWMU#2	Schwartz Road Landfill
SWMU#5	Flight Crew Rescue Training Area
SWMU#6	Fire Training Area Hypergol Tank Facility
SWMU#11	Solid Waste Incinerator
SWMU#12	Industrial Boiler for Waste Oil (Central Heat Plant-Boiler #3)
SWMU#17	Sewage Treatment Plant (STP) #4
SWMU#18	Sewage Treatment Plant (STP) #1
SWMU#19	Sewage Treatment Plant (STP) #10

Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) Requiring No Further Action at this time (continued)	
SWMU/AOC No/Letter	**SWMU/AOC Name**
SWMU#20	Spaceport Diesel Storage Area – includes SWMU #24d (Cleanup under Chapter 62-770)
SWMU#22	Schwartz Road Sandblast Area
SWMU#23	Parachute Facility
SWMU#24a	Oil/Water Separators - Base Support Building - made part of SWMU #14
SWMU#24b	Oil/Water Separators - Generator Operations Shop - made part of PRL #115
SWMU#24c	Oil/Water Separators - VAB Utility Annex - made part of SWMU Assess for facility
SWMU#24d	Oil/Water Separators - made part of Spaceport Diesel Petroleum Investigation
SWMU#25	K7-165, Hazardous Waste Facility
SWMU#26	M7-1361, Hazardous Waste Storage Facility
SWMU#27	90-day Accumulation Sites
SWMU#28	Satellite Accumulation Areas
SWMU#29a	Other Sewage Treatment Plants - STP-5
SWMU#29b	Other Sewage Treatment Plants - STP-6
SWMU#33	LC-39B MEK Spill
SWMU#34	Contractors Road Sandblast Area
SWMU#38	Canister Rotation Facility, M7-777 - Industrial Wasterwater Tank
SWMU#40	Thermal Protection Facility, K6-794 - 500 gallon Wastewater Tank
SWMU#41	Components Refurbishment & Chemical Analysis Facility, K6-1964 - Process Waste Water Tanks
SWMU#63	Old Rifle Range
PRL#36	GSA North Fuel Facility
PRL#37	M&O Fuel Facility
PRL#38	Former U.S.FWS Fuel Facility (made part of SWMU #71)
PRL#40	Payload Hazardous Servicing Facility Spill
PRL#41	Old Bus Maintenance Facility
PRL#42	S-Band Tank
PRL#43	LC-39B Transformer Pad Spill, J7-1388
PRL#44	Environmental Health Facility, L7-1557C Tank
PRL#45	CCAFS Administration Building, Building 1385
PRL#47	LC-39B Remote Air Intake Building, J7-432
PRL#48	LC-39B RP-1 Facility, J7-292
PRL#49	C-5 Emergency Power Station, K6-1091
PRL#50	Payload Hazardous Servicing Facility Spill, M7-1354
PRL#51	Launch Equipment Shop, K6-1247 (Cleanup under Chapter 62-770)
PRL#52	VAB Repeater Station, K6-1193 (Cleanup under Chapter 62-770)
PRL#53	VAB Safe Haven, K6-743 (Cleanup under Chapter 62-770)
PRL#54	LC-39B, J7-243 (Cleanup under Chapter 62-770)
PRL#55	OPF-1 &2 Fuel Spill, K6-894 (made part of SWMU #72)
PRL#56	GSA Automotive Facility, M6-689 (made part of SWMU # 10)
PRL#58	LC-39A Remote Air Intake Building, J8-1735
PRL#59	Ordnance Lab #2, M7-1417
PRL#62	Shuttle Landing Facility Midfield Park Site
PRL#63	STP #1 Sludge Disposal Area
PRL#64	Central Instrumentation Facility (CIF) Cooling Tower Discharge Area
PRL#65	Operations & Checkout (O&C) Bldg Cooling Tower Discharge Area
PRL#66	Engineering Development Laboratory (EDL) Cooling Tower Discharge Area
PRL#67	Vertical Processing Facility (VPF) Cooling Tower Discharge Area
PRL#68	Parachute Refurbishment Facility (PRF) Cooling Tower Discharge Area

Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) Requiring No Further Action at this time (continued)	
SWMU/AOC No/Letter	**SWMU/AOC Name**
PRL#70	Operations Support Building (OSB) Cooling Tower Discharge Area
PRL#71a	Vehicle Assembly Building (VAB) Utility Annex Cooling Tower Discharge Area -1
PRL#71b	Vehicle Assembly Building (VAB) Utility Annex Cooling Tower Discharge Area -2
PRL#72	SRB-ARF Cooling Tower Discharge Area
PRL#76	Launch Equipment Test Facility (LETF) Runoff Pond
PRL#77a	Sludge Disposal Areas - O&C Front Lawn
PRL#77b	Sludge Disposal Areas - CIF Front Lawn
PRL#77c	Sludge Disposal Areas - Crawlerway Residual Area
PRL#78	Contractor Support Building #7
PRL#81	Old Service Station Tank
PRL#83	Water & Waste Support Building
PRL#85	Spaceport USA Cooling Tower
PRL#86a	Industrial Area Sewage Treatment Ponds – STP-2
PRL#86c	Industrial Area Sewage Treatment Ponds – STP-16
PRL#87a	Abandoned LC-39 Sewage Treatment Ponds - STP-9
PRL#87b	Abandoned LC-39 Sewage Treatment Ponds - STP-17
PRL#89	Industrial Area Boiler Discharge Area (HMF Heat Plant)
PRL#92	Support Building, F5-2151
PRL#93	USBI Assembly and Refurbishment
PRL#95	Shuttle Landing Facility South Area
PRL#97	Contractors Road Railcar Site
PRL#106	Multi-Payload Processing Facility, M7-1104
PRL#107	MINWR Maintenance Facility
PRL#108	SAEF II Cooling Tower Discharge Area
PRL#USAF90	Tel IV Central Telemetry Station
PRL#114a	KSC Background Study Location – SSC054
PRL#114b	KSC Background Study Location – DUNE-61
PRL#114c	KSC Background Study Location – MARSH-4S
PRL#114d	KSC Background Study Location – WEST-3D
Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) Requiring SWMU Assessments and/or Confirmatory Sampling	
SWMU/AOC No/Letter	**SWMU/AOC Name**
SWMU#36	GSA Reclamation Yard West
SWMU#37	Former Drum Storage Area, J7-2112
PRL#57a	Agricultural Sheds - Roberts Road
PRL#57b	Agricultural Sheds - Jerome Road
PRL#60	Convertor/Compressor Building, K7-468
PRL#61	Spacecraft Assembly & Encapsulation Facility 2 (SAEF 2), M7-1210
PRL#73	Spaceflight Tracking and Data Network (STDN), MILA Station
PRL#74	Non Destructive Evaluation Lab
PRL#96	Prototype Shop, M7-581
PRL#98	Oak Hill Grove Site
PRL#99	Launch Umbilical Tower (LUT) #1 Storage Area
PRL#103	OPF 3, K6-696
PRL#111	Engineering Development Laboratory (EDL), M7-409
PRL#112	Central Instrumentation Facility (CIF), M6-342
PRL#113	Parachute Refurbishment Facility (PRF), M7-657

Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) Requiring SWMU Assessments and/or Confirmatory Sampling (continued)	
SWMU/AOC No/Letter	**SWMU/AOC Name**
PRL#115	Generator Operations Shop, K6-1446
PRL#116	Payload Hazardous Servicing Facility (PHSF), M7-1354
Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) Undergoing Corrective Action (CA)	
SWMU/AOC No/Letter	**SWMU/AOC Name**
SWMU#1	Wilson Corners
SWMU#14	Maintenance and Operations (M&O) Facility - includes Battery Acid Dump Site #2
SWMU#15	Contractors Road Acid Dump Site - part of SWMU 55
SWMU#16	Sewage Treatment Plant (STP) #15 - part of SWMU 55
SWMU#21	Ransom Road Sandblast Yard - includes STP-14, PRL #86b
SWMU#30	Components Cleaning Facility (CCF)
SWMU#31	Printed Circuit Board Shop - part of SWMU 55
SWMU#35	VAB Utility Annex
SWMU#43	East Crawler Park Site
SWMU#44	West Crawler Park Site - includes South Crawler Park Site, PRL #84
SWMU#55	Contractors Road Heavy Equipment Area - includes SWMUs 15, 16, and 31
SWMU#64	Suspect Rail Car Siding
SWMU#65	Hypergol Support Building, M7-1061 (formerly PRL #79)
SWMU#66	C-5 Electrical Substation, K6-1141 (formerly PRL #75)
SWMU#68	Jay Jay Railroad Yard (formerly PRL #96)
SWMU#69	Firex Water Tank (formerly PRL #82)

Table 10-2 lists the sites on the Air Force HSWA permit that KSC is currently managing.

Table 10-2. SWMU Summary on CCAFS.

Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) Requiring a RCRA Facility Investigation (RFI)	
SWMU/AOC No/Letter	**SWMU/AOC Name**
SWMU#54 CCAFS	Launch Complex 34
SWMU#58 CCAFS	Hangar AF
SWMU#C057 CCAFS	Fuel Storage Area #1

10.1.4 LAND USE CONTROLS (LUC)

By separate Memorandum of Agreement, effective February 23, 2001, EPA, FDEP, and KSC, on behalf of NASA, agreed to implement Center-wide, certain periodic site inspection, condition certification, and agency notification procedures designed to ensure the maintenance by Center personnel of any site-specific LUCs deemed necessary for future protection of human health and the environment.

LUCIPs are generally prepared for sites undergoing some type of corrective action and will remain in place until the site conditions requiring land use controls are eliminated.

SECTION XI

NOISE

11.1 REGULATORY OVERVIEW

Congress enacted the Federal Noise Control Act in 1972 (42 USC §4901 et. seq.). This act was designed to promote an environment that is free from noise that might jeopardize the health and welfare of the population of the United States. The Act provided a means for coordinating Federal research and activities in noise control, to authorize the establishment of noise emission standards for products distributed in commerce, and to provide information to the public respecting the noise emission and noise reduction characteristics of such products. In 1978, the Quiet Communities Act (42 USC §4913) directed the Federal Government to develop and disseminate noise control information and educational materials to the public, conduct research into the effects of noise on humans, animals, wildlife, and property, and investigate the economic impact of noise on property and human activities.

Both of these Acts resulted in the promulgation of regulations regarding the noise produced by transportation-related equipment such as locomotives, trucks, and construction equipment (40 CFR 201-211). However, Federal regulations governing low noise emission requirements for products exclude any rockets or equipment, which are designed for research, experimental, or developmental work to be performed by NASA (40 CFR 203.1).

The Noise Control Act directed the Environmental Protection Agency (EPA) to publish information about the effects of different qualities and quantities of noise. It also defined acceptable levels of noise under various conditions that would protect public health and welfare. The noise guidelines published by EPA identify a day/night sound level (Ldn) of less than 55 dBA as adequate to protect outdoor activities against interference and annoyance due to noise (Ref. 1).

EPA prefers the Ldn parameter for assessing environmental noise impacts (EPA, 1974). It is the energy average of all the noise occurring throughout the 24-hour day, but with a 10-decibel penalty added to the nighttime hours between 10 p.m. and 7 a.m. to account for the greater sensitivity of people to noise at night. This guideline level is commonly used as a basis for judging the acceptability of facility noise at residential and other sensitive receptors. Other Governmental agencies such as the Department of Housing and Urban Development (HUD) and the Department of Defense (DOD) define outdoor Ldn levels up to 65 dBA as acceptable for residences.

11.2 AMBIENT NOISE

The 24-hour average ambient noise level on KSC is appreciably lower than the EPA recommended upper level of 65 decibels (dBA). This is on a scale ranging from approximately 10 dBA for the rustling of grass or leaves to 115 dBA, the unprotected hearing upper limit for exposure on a missile or space launch. The areas of KSC/MINWR away from operational areas are exposed to relatively low ambient noise levels in the range of 35 to 40 dBA.

11.3 MAN-MADE SOURCES OF NOISE

Noise generated at KSC by day-to-day operations, space vehicle launches, and Orbiter landings can be attributed to six general sources: (1) Orbiter reentry sonic booms, (2) launches, (3) aircraft movements, (4) industrial operations, (5) construction, and (6) traffic noise. Table 11-1 measures noise levels at KSC (Tables 11-2 and 11-3 are provided for reference). Items (1) and (2) will be further detailed in Section XI.

11.3.1 AIRCRAFT MOVEMENTS

A number of aircraft are utilized at KSC for payload delivery, ferry support, NASA executives, security, and astronaut training. Typically, noise levels are expected to be no greater than those experienced by a small commercial airport. See Tables 11-2 and 11-3 for noise levels generated by typical aircraft.

11.3.2 INDUSTRIAL ACTIVITIES

Hydraulic pumps operating within the confines of their enclosures will produce the loudest noise generated by industrial activities at KSC. Operators will be required by Occupational Safety and Health Administration (OSHA) regulations to be equipped with ear protection devices when exposed to these levels. Other intermittent raised levels of noise will occur during operation of lifting equipment, diesel-powered generators and locomotives, heavy-duty service vehicles, and the Crawler Transporter by certain sheet metal forming and cutting processes and by aqualaser removal of residual thermal protection materials from recovered SRB's. Even the highest levels of noise from industrial activities will have minor impact on the environment and none will affect areas beyond the KSC boundaries (see Table 11-3 for construction noise sources).

11.3.3 VEHICULAR TRAFFIC

The intermittent noise of arriving and departing vehicles (including visitors to the Space Center, the Merritt Island National Wildlife Refuge, and the Canaveral National Seashore) is expected to be no greater than that experienced in a major shopping center parking lot. Table 11-1 presents typical noise levels at the KSC Industrial Area.

11.3.4 NOISE ABATEMENT

A number of permanent and/or temporary measures may be taken to reduce noise levels at KSC. Potential noise abatement measures for any facility or operation include:

- Property acquisition for uses as a buffer zone
- Landscaping with high dense vegetation or earthen berm

- Noise insulation of buildings
- Erect permanent noise barriers
- Proper scheduling (day/night of a specified activity might eliminate or alleviate noise impacts during critical periods)

Table 11-1. Measured Noise Levels at KSC.

Source	DBA Low	Range High	Remarks
Re-Entry Sonic Boom [1]			
Orbiter			101 N/m2 max. (2.1 psf)
SRB Casing			96 to 144 N/m2 (2 to 3 psf)
External Tank			96 to 192 N/m2 (2 to 4 psf)
Launch Noise			
Titan IIIC	[2]	94	21 Oct 165 (9,388 m)
Saturn I	[2]	89	Avg. of 3 (9,034 m)
Saturn V	[2]	91	15 Apr 1969 (9,384 m)
Atlas	[2]	96	Comstar (4,816 m)
Space Shuttle [1]		90	1.4 dBA Down from Saturn V (9,384 m)
Aircraft			
F4 Jet	[2]	107	18 km from Ground Zero
F Jet	[2]	158	Calculated at Ground Zero
NASA Gulfstream	87	109	Takeoff (Marker 14)
NASA Gulfstream	87	100	Landing (Marker 14)
Industrial Activities			
Complex 39A	71	78	Transformers
LETF	89	92	Hydraulic Charger Unit
Machine Shop	89	112	Base Support Building M6-486
Computer Room	85	88	VAB – Room 2K11
Snack Bar	[2]	60	CIF – Room 154
Laboratories	45	58	CIF – Rooms 139 and 282
Elevator	[2]	62	Central Instrumentation Facility
VAB High Bay	75	108	Welding, Cutting, etc.
VAB High Bay	106	116	Chipping
Hangar AE	[2]	77	Room 125 During Test
Headquarters Office	58	75	Room 2637 and Printers
O&C Office	[2]	57	Room 2063
Mobile Launcher Platform	70	94	Room 2063
Mobile Launcher Platform	82	199	2 Pumps Operating 5K Load
Industrial Area	55	66	15 m from Traffic Light
Undisturbed Areas			
Seashore	50	69	Medium Waves (Nice Day)
Riverbank	48	48	Light Gusts (No Traffic)
150 m Tower	50	64	Light Gusts of Wind

[1] Estimated.
[2] Not measured or not applicable.

SOURCE: Ref. 2.

Table 11-2. Aircraft and Weapons Noise Levels.

Type Aircraft	Takeoff		Landing	
	DBA	**(EPNdBA) [1]**	**DBA**	**(EPNdBA)**
727, 737, DC9, BAC111	94-100	92-96	85-90	97-104
707, 720, DC8	100-105	-	94-100	-
747, Wide-body	103	107-115	92	104-114
DC10, L1011	90	95-106	84	99-108
DC3, Propeller	85-90	-	75-82	-
Single-Engine Propeller	76-90	77-78	67-77	87-88
Multi-propeller	76-90	-	67-77	-
Executive Jet	93-97	83-94	70-80	92-101
OH58 (Ranger Helicopter)	84	-	81-87	-
UH1 (Huey Helicopter)	77	-	2	-
C141 (Cargo Plane)	134	-	77	-

[a] EPNdBA: Effective Perceived Noise Level.
[b] Assume atmospheric absorption of 1dB/100 ft.
SOURCE: Ref. 3.

During periods of construction, noise attenuation is generally not possible. Decreases in efficiency due to such efforts would increase construction costs and the time period over which the impacts would occur. However, with little planning the use of portable sound screens and the strategic placement of stationary machinery noise impacts could be significantly minimized.

11.3.5 ENVIRONMENTAL IMPACTS OF NOISE

11.3.5.1 Wildlife. Studies have been conducted on the noise impacts on wood storks from launch operations. During the 1990 nesting season, studies were made on the Bluebill Creek colony before and after the April 24 launch from Pad B and a Titan IV launch from CCAFS Pad 41 on June 12. A startle response occurs during launches from either Shuttle pads, but within 10 minutes the colony appeared to be functioning normally and no young wereobserved to be injured or killed from startle effects. Experts consulted on the subject concluded that noise levels in the frequency and power range observed may be harmful to birds, but very little information is available. Site visits made before and after the launches did not indicate any obvious adverse effects. Bluebill Creek colony has continued to be active, but the numbers of birds nesting there have been declining. This is presumably due to the deterioration of the large mangroves (used as nest sites) killed in previous winter freezes. Bluebill Creek was also often used as a roost site by wading birds, cormorants, and brown pelicans. Freezes have destroyed the mangroves in this area and it is no longer a rookery area.

The Base Operations Contractor Industrial Hygiene Office A performed a noise survey on March 14, 1990, to assess the noise levels in the habitat of scrub jays and beach mice during a Titan 34D launch from Complex 40. Noise levels are reported for four sampling sites. No conclusions can be drawn from the field data; however, ongoing observations of the scrub jay do not indicate any adverse impact (Ref. 4).

Table 11-3. Construction and Vehicular Noise Sources, dBA.

Source	Noise Level (Peak)	Distance from Source [a] 50 ft	100 ft	200 ft	400 ft
Construction					
Heavy Trucks	95	84-89	78-83	72-77	66-71
Pickup Trucks	92	72	66	60	54
Dump Trucks	108	88	82	76	70
Concrete Mixer	105	85	79	73	67
Jackhammer	108	88	82	76	70
Scraper	93	80-89	74-82	68-77	60-71
Dozer	107	87-102	81-96	75-90	69-84
Paver	109	80-89	74-83	68-77	60-71
Generator	96	76	70	64	58
Shovel	111	91	85	79	73
Crane	104	75-88	69-82	63-76	55-70
Loader	104	73-86	67-80	61-74	55-68
Grader	108	88-91	82-85	76-79	70-73
Caterpillar	103	88	82	76	70
Dragline	105	85	79	73	67
Shovel	110	91-107	85-101	79-95	73-89
Dredging	89	79	73	66	60
Pile Driver	105	95	89	83	77
Ditcher	104	99	93	87	81
Fork Lift	100	5	89	83	77
Vehicles					
Diesel Train	98	80-88	74-82	68-76	62-70
Mack Truck	91	84	78	72	66
Bus	97	82	76	70	54
Compact Auto	90	75-80	69-74	63-68	57-62
Passenger Auto	85	69-76	63-70	57-64	51-68
Motorcycle	110	82	76	70	64
[1] Assume 6 dBA decrease for every doubling of distance.					
Source: Ref. 3.					

Studies were conducted on wading bird colonies subjected to military overflights (500 ft of altitude) with noise levels up to 100 dBA. No productivity limiting responses were observed (Ref. 5). Nesting birds are apparently more startled by human presence in the vicinity of the nest than by noise impacts.

Bald eagles utilizing a nest adjacent to the Kennedy Parkway at KSC have received episodic sound exposures of 102 dBA during STS launches. Observation showed that the startle response to such high noise levels was short-term and caused no significant impact (Ref. 6).

Studies of reproductive success and survival of Florida scrub jays have been conducted surrounding USAF Titan IV launch pads 40 and 41 (Ref. 7). No acute or obvious direct impacts have been found resulting from several launches where noise levels approached 140 dB.

11.3.5.2 Man. The effects of noise on man are outlined in Table 11-4. To ensure the protection of employees' hearing OSHA has outlined permissible noise exposures (see Table 11-5). 29 CFR Section 1019.95 states that personnel exposed to an 8-hour time-weighted average of 85 dBA or greater must be issued hearing protectors.

Table 11-4. Effects of Noise on Humans.

DBA Level	Potential Effect
20	No sound perceived
25	Hearing threshold
30	--
35	Slight sleep interference
40	--
45	--
50	Moderate sleep interference
55	Annoyance (mild)
60	Normal speech level
65	Communication interference
70	Smooth muscles/glands react
75	Changed motor coordination
80	Moderate hearing damage
85	Very annoying
90	Affect mental and motor behavior
95	Severe hearing damage
100	Awaken everyone
105	--
110	--
115	Maximum vocal effort
120	--
125	Pain threshold
130	Limit amplified speech
135	Very painful
140	Potential hearing loss high
Source: Ref. 3.	

Table 11-5. Permissible Noise Exposures [1] (29 CFR 1910.95).

Duration Per Day, Hours	Sound Level dBA Slow Response
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
½	110
¼ or less	115

[1] When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: C/T + C/T +…Cn/Tn exceeds unity, then the mix of exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specific noise level and Tn indicates the total time of exposure. Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

11.3.4 REFERENCES

1. EPA/ONAC 550/9-74-004, March 1974. "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety."

2. Environmental Impact Statement: Space Shuttle Program. 1978. NASA, Washington, D.C.

3. Ardaman and Associates, Inc. 1984. Subsurface Exploration OMRF Building, Kennedy Space Center, Preliminary Engineering Documentation for OMRF Building. Cocoa, Florida.

4. Base Operations Contractor. Memorandum to Mark Mercadante, LBS-6380 dated March 28, 1990. Noise Survey - Complex 40 Titan Launch - Complex 40 Titan Launch.

5. Black, B.B., M.W. Collipy, H.F. Percival, A.A. Tiller, and PG.G. Bohall. 1984. Effects of Low Level Military Training Flights on Wading Bird Colonies in Florida. Florida Coop. Fish and Wildl. Res. Unit, Sch. For. Res. And Sonserv., Univ. of Florida. Tech. Rept. No. 7.

6. Environmental Effects of the STS-1 Flight Readiness Firing and Launch. 1981. John F. Kennedy Space Center, Florida.

7. Breininger, D.R., M.J. Kehl. 1990. Report to Clay Gordin/6550 ABG/DEEV on 5 July, 1990.

SECTION XII

CULTURAL RESOURCES

12.1 REGULATORY OVERVIEW

The principal Federal legislation governing the management of cultural resources or historic properties, on Federal, Native American, and tribal lands include the Antiquities Act of 1906, the Historic Sites Act of 1935, the National Historic Preservation Act of 1966, as amended, the National Environmental Policy Act of 1969, Executive Order 11593: *Protection and Enhancement of the Cultural Environment (1971)*, the Archaeological and Historic Preservation Act of 1974, the American Indian Religious Freedom Act of 1978, the Archaeological Resources Protection Act of 1979, and the Native American Graves Protection and Repatriation Act of 1990. Other Federal authorities, which address Native American cultural resources include Execution Order 13007: *Indian Sacred Sites (1996)* and Executive Order 13175: *Consultation and Coordination with Indian Tribal Governments (2000)*. Chapter 267 of the Florida Statutes (F.S.) contains legislation, which parallels the Federal requirements on the State level.

NASA/KSC's compliance with all of these statutes is accomplished by adherence to the Section 106 process on the Federal level and the historic preservation compliance review program of the Florida Department of State, *Division of Historical Resources (DHR)* at the State level. Since the DHR has incorporated the Section 106 process into the State's uniform compliance review program, the two processes are identical.

National Historic Preservation Act (NHPA) of 1966, as amended (Public Law [PL] 89-665).

The National Historic Preservation Act of 1966, as amended, is the keystone of Federal historic preservation law. Among the fundamental provisions of the Act is Section 106, which requires all Federal agencies to take into consideration the effect of Federally assisted, licensed or permitted projects on cultural resources that are listed, or eligible for listing, in the *National Register of Historic Places (NRHP)*. [Listing in the National Register, or meeting the criteria of eligibility, is a basic prerequisite for a cultural resource to benefit from protection and assistance under Section 106. The Secretary of the Interior through the National Park Service (NPS) administers the National Register.] Section 106 of the NHPA also requires that the ACHP be afforded an opportunity to comment on such effects. The process for accomplishing the provisions of Section 106 are contained in the implementing regulations 36 CFR Part 800 (revised, January 2001), issued by the ACHP.

Section 110 of the NHPA (as amended) obligates Federal agencies to establish a historic preservation program for the identification and protection of historic properties under their jurisdiction, and to ensure that such properties are managed and maintained in a way that considers their historic and cultural values. Section 110(b) requires Federal agencies to document historic properties that may be destroyed or altered as a result of Federal actions or assistance. Section 110(d) calls for agencies to integrate historic preservation concerns into their plans and programs.

National Environmental Policy Act (NEPA) of 1969 (PL 91-190).

The National Environmental Policy Act of 1969 requires consideration of the environmental impacts of Federal actions, including impacts on cultural resources. The Act declares that it shall be the continuing responsibility of the Federal Government to "preserve important historic, cultural, and natural aspects of our national heritage." Consequently, Section 102(c) requires that an Environmental Impact Statement (EIS) be prepared when Federal actions significantly affect the quality of the human environment, including cultural resources. Compliance with NEPA can and should be coordinated with the Section 106 review, although compliance with one statute does not substitute for compliance with the other.

Executive Order (EO) 11593: Protection and Enhancement of the Cultural Environment.

Executive Order 11593, signed by President Richard Nixon in 1971, requires all Federal agencies to identify archaeological and historic properties under their jurisdiction that are eligible for listing in the *NRHP* and to take steps to avoid impacting them. It also calls for the complete documentation of any *NRHP* eligible site or property that will be demolished as a result of a Federal undertaking.

American Indian Religious Freedom Act (AIRFA) of 1978 (PL 95-341).

The American Indian Religious Freedom Act of 1978 establishes as Federal policy the protection of the rights of Native American tribes to the free exercise of their religion, including access to sacred sites and requires Federal agencies to evaluate their programs to accommodate this policy. AIRFA also has he effect of requiring serious efforts to include Native Americans in the consultation process under Section 106.

Archaeological Resources Protection Act (ARPA) of 1979 (PL 96-95).

The Archaeological Resources Protection Act of 1979 prohibits unauthorized excavation of archaeological resources on Federal and Native American land without a permit issued by the relevant land management agency. It also prohibits the sale, receipt, and interstate transportation of archaeological resources obtained illegally (without permits) from public or Native American land, and establishes substantial civil and criminal penalties for violations. ARPA prescribes standards that must be met by the permit applicant. Where both ARPA and Section 106 of the NHPA apply (e.g., where data recovery is proposed on Federal land), it is important to coordinate ARPA and Section 106 compliance.

Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (PL 101-601).

The Native American Graves Protection and Repatriation Act prohibits the intentional removal of Native American cultural items from Federal or tribal lands except under an ARPA permit and in consultation with the appropriate Native American groups. It also requires Federal agencies and museums receiving Federal funds to inventory Native American human remains and associated funerary objects and develop written summaries for unassociated funerary objects, sacred objects, and objects of cultural patrimony that are in the collections they own or control. Another principal intention of the Act is protection, on Federal and/or tribal land, of Native American graves and other cultural items located within archaeological sites. NAGPRA contains provisions for the return (repatriation) of human remains and other cultural items held by Federal agencies and museums that receive Federal support to the appropriate Native American groups or descendants, upon their request.

Executive Order (EO) 13007: Indian Sacred Sites and
Executive Order (EO) 13175: Consultation and Coordination with Indian Tribal Governments.

Executive Order 13007, issued by President William J. Clinton on May 24, 1996, requires Federal agencies to protect Indian sacred sites by avoiding adverse effect to the physical integrity of such sites. It also accommodates access to and ceremonial use of Indian sacred sites by Indian religions practitioners, and, where appropriate, requires Federal agencies to maintain the confidentiality of information on such sites.

Executive Order 13175, signed by President Clinton in 2000, renews Federal commitment to meaningful consultation with Native American tribes concerning Federal agencies, renews Federal commitment to the recognition of tribal sovereignty, and recognizes Government-to-Government relationship between Native American tribes and the U.S. Government.

Chapter 267, Florida Statutes (F.S.).

Chapter 267, F.S. (Florida Historical Resources Act) is the principal State law regarding protection of archaeological and historical resources, and it also contains requirements similar to those of the Federal NHPA. The Act declares it to be State policy to protect and preserve archaeological and historical sites that "have scientific or historical value or are of interest to the public" (Chap. 267.061[1][a]). The Florida DHR is charged with administering the Act and, on behalf of the State, implementing the provisions of the NHPA.

12.2 HISTORY OF LAND ACQUISITION

NASA/KSC became a resident of Cape Canaveral in 1958 when the Army Missile Firing Laboratory (MFL), then working on the Saturn rocket project managed by Kurt Debus, was transferred to NASA/KSC. Several Army facilities at CCAFS were given to NASA/KSC, including Launch Complexes 5, 6, 26, and 34 with various offices and hangers. MFL was renamed to Launch Operations Directorate (LOD) and became a branch office of Marshall Space Flight Center (MSFC) in Huntsville. Alabama. As LOD’s responsibilities grew, NASA/KSC granted the launch team to increase status by making it a field center called the Launch Operations Center (LOC) and separating it from MSFC.

When President John F. Kennedy began the Man-to-the-Moon project, CCAFS land was insufficient to house further rocket facilities. New land was required to support expanded launch structures. Merritt Island, an undeveloped area west and north of the Cape, was selected for acquisition, and in 1961 the Merritt Island Launch Area (MILA) was born. In that year, NASA/KSC requested from Congress authority to purchase 323.8 km^2 (125.0 mi^2) of property. This was formally granted in 1962. The U.S. Army Corps of Engineers (ACOE) acted as agent for purchasing land, which took place between 1962 and 1964. NASA/KSC began gaining title to the land in late 1962, taking over 33,955.9 ha (83,903.9 ac) by outright purchase.

Negotiations with the State of Florida provided submerged lands, resulting in the acquisition of property identified on the original Deed of Dedication. Much of the State-provided land was located south of the Old Haulover Canal and north of the Barge Canal. The purchase of KSC land included several small towns, such as Orsino, Wilson, Heath and Audubon, many farms, citrus groves, and several fish camps. In 1963, LOC and MILA were renamed the John F. Kennedy Space Center to honor the late President.

An Air Force request in 1962 for space to install new Titan rocket facilities (Complexes 40 and 41) at the south end of NASA/KSC's newly purchased land prompted a re-evaluation of the total land buy. Negotiations between NASA and the Air Force resulted in the purchase of an additional 59.6 km^2 (23.0 mi^2) of land in 1963, lying north and east of the Old Haulover Canal, including the towns of Allenhurst and Shiloh. This land was purchased by the ACOE with Air Force money in compensation for 140.4 ha (346.9 ac) taken by CCAFS for the two Titan launch facilities. Total holdings of KSC-owned land increased to 569.7 km^2 (219.9 mi^2). The State of Florida provided an additional 227.1 km^2 (87.7 mi^2), bringing the total of donated submerged land to 22,580 ha (55,795 ac).

In 1983, KSC increased its holdings when the Florida East Coast (FEC) Railway requested a buy-out of its property east of Titusville, including the Jay-Jay rail yard. NASA acquired 74.9 ha (185.1 ac) as the result of this purchase.

12.3 PREHISTORIC AND HISTORIC CONTEXTS

KSC lies within the East and Central Florida culture area, which is composed of the “lower (northern) and central portions of the St. Johns River, its tributaries, adjacent portions of the coastal barrier island-salt marsh-lagoon system, and the Central Florida Lake District” (Ref. 1). This region was home to the St. Johns cultures, which developed out of the late Archaic period Orange culture. The primary trait common throughout the culture area is the distinctive chalky St. Johns pottery.

Previously, KSC was included in the Indian River Area, which begins at the northern headwaters of the coastal Indian River lagoon and extends south to the St. Lucie Inlet. Archaeologically, the Indian River Area differs from the northern St. Johns Area primarily by the inclusion of significant amounts of sand-tempered pottery in the ceramic assemblages. The sequence of pre-columbian cultures within this zone, first described by Irving Rouse (Ref. 2), parallels that of the St. Johns region. Rouse's Malabar I period is equivalent to the St. Johns I period, and Malabar II is the temporal equivalent of St. Johns II (Ref. 1). A chronological sequence of prehistoric cultures for the St. Johns region (Ref. 1), as well as the major proto-historic and historic periods, is summarized in Table 12-1 along with examples from various KSC sites.

Table 12-1. Summary of Prehistoric and Historic Contexts.

PERIOD/DATE	DISTINGUISHING TRAITS, EVENTS, AND PERSONS	SELECTED KSC SITES
Paleoindian 10,000-7000 B.C.	Migratory hunters and gatherers. Dry climate. Lower sea level. Fresh water scarce. Suwannee and Simpson-type projectile points; unifacial tools.	None identified, with small likelihood (with the possible exception of the Haulover area).
Early Archaic 7000-4000 B.C.; Middle Archaic/ Mt. Taylor 4000-2000 B.C.	Early Archaic burials (cf. Windover Site) placed in peat-producing ponds or sloughs. Riverine exploitation of fresh water shellfish (e.g., pond snail) became extensive during the Middle Archaic/Mt. Taylor. Pre-ceramic.	None identified. Environmental conditions probably not conducive to settlement. Pre-ceramic coastal shell middens (Mt. Taylor) considered unlikely.
Orange/ Late Archaic 2000-1000 B.C.	First occupation of the coastal lagoon; first pottery (fiber-tempered); first coastal-estuarine shell middens (predominantly coquina). Shift to coastal shellfish and fishing subsistence. Increased sedentism. Virtual absence of oysters and heavy use of coquina imply a different environment than today.	8BR79 (Titusville Beach); 8BR170 (Opposite Futch Cove); 8BR205 (Max Hoeck Midden); 8BR774 (Astronaut Road)
Florida Transitional 1200-500 B.C.	Lower sea level. Earlier sites may be inundated. First semi-fiber-tempered pottery. Regionalism begins. Greater dependence on coastal and lagoon resources. St. Johns Incised ceramics.	8BR78 (Dummett's Place); 8BR205 (Max Hoeck Mound and Midden); 8BR774 (Astronaut Road)
St. Johns I 500 B.C.-A.D. 800	Continuation of hunting/fishing/gathering way of life. First burial mounds. St. Johns Plain and Incised pottery; also, Dunns Creek Red is common. Weeden Island influences. Shift in dominance from clams to oysters reflect environmental change in Mosquito Lagoon.	8VO130, 131 (Ross Hammock Mounds and Midden); 8VO129 (Bill's Hill/Scobey Place); 8BR139 (Dummit Grove NE); 8BR205 (Max Hoeck Mound and Midden); 8BR1622 (Allenhurst Midden); 8BR1673 (Haulover Sand Mound and Midden)
First Spanish A.D. 1513-1763	Limited Spanish settlement. European artifacts include Spanish metal, glass, and pottery (majolica, olive jar, other coarse earthenwares). French Hugenauts led by Jean Ribault massacred in 1565 by Menendez, founder of St. Augustine. Alvaro Mexia sent (1605) by the Spanish Governor to visit the Ais Indians on a diplomatic mission. His *Derrotero* contains descriptions of a number of Indian villages, possibly located within KSC: Surruque (near Ross Hammock); Urruya (Haulover Canal area); and Suyagueche (near Max Hoeck Creek). 1696 shipwreck of the Jonathan Dickinson party.	8BR84 (Ribault site); 8VO130, 131 (Ross Hammock Mounds and Midden); 8BR1632 (Edgar/ Campbell Midden)

PERIOD/DATE	DISTINGUISHING TRAITS, EVENTS, AND PERSONS	SELECTED KSC SITES
British A.D. 1763-1783	Turnbull's New Smyrna Colony (1767-1783) established along the northern Indian River. Settlement in KSC-area is unknown. Possible establishment of Ross' Plantation at Ross Hammock. Extent of British development in the area was not great.	None identified.
Second Spanish A.D. 1783-1821	Spanish land grants include 1200 acre H.M. Gomez grant (1803); the 1000-acre Francisco Reyes grant (1804); the 1821 Lucas Crayon grant (originally the Reyes grant); and the 1822 Antelm Gay grant (300 acres within the Gomez grant).	8VO130, 131 (Ross Hammock Mounds and Midden)
American A.D. 1821-1949	Sparse white settlements. 1820s-30s - height of local sugar cane production. All local sugar plantations destroyed during the Second Seminole War. Douglas Dummett, who established the first orange grove at KSC in the 1840s, led a local militia company during the Second Seminole War (1835-1842). Fort Ann established in 1837 during the Second Seminole War to protect the Haulover; abandoned in 1838. "Old" Haulover Canal constructed in 1854. Civil War period Confederate Saltworks at Ross Hammock reportedly destroyed in 1862. Dummett groves, the largest in the state by 1867, were the beginning of the Indian River citrus fruit industry. In 1869, Nicole Tamajo builds octagonal-shaped house next to Dummett's grove. "New" Haulover Canal constructed in 1887, one mile north of the old. Chester Shoals House of Refuge/Coast Guard Station constructed in 1884, and in use for 50 years. Cape Canaveral Air Force Station established in the 1940s.	8BR175 (Fort Ann); 8BR78 (Dummett Homestead); 8BR188 (Old Haulover Canal); 8VO160 (Sugar Mill Ruins); 8VO213 (Confederate Salt Works)
Modern A.D. 1950 +	America enters the Space Age on July 24, 1950. NASA begins operations at Cape Canaveral in 1958. In 1961, the Merritt Island Launch Area was born. Early 1960s - property acquired for the Kennedy Space Center. Apollo Program dated from 1961 through 1975. VAB and Launch Complex 39 constructed between 1962 and 1968. Merritt Island National Wildlife Refuge established in 1972. Canaveral National Seashore created in 1975	Vehicle Assembly Building (8BR1684); Launch Control Center (8BR1685); Launch Complex 39 Pad A (8BR1686); Headquarters Building (8BR1691); Central Instrumentation Facility (8BR1692)

The summary of relevant information on the prehistory and history of KSC in terms of such characteristics as patterns of settlement, subsistence, and technological developments is provided in order to develop the **historic context**, a recommended component of a Culutural Resources Management Plan (CRMP) (Ref. 3). This organizational framework describes "the significant, broad patterns of developments in an area that may be represented by historic properties" (Ref. 3). Simply stated, the historic context provides a baseline for significance evaluations and resource management decisions.

12.3.1 PREVIOUS INVESTIGATIONS

Since the mid-1800s, investigators have studied the Cape Canaveral area. Since the late 1960s, numerous archaeological and historical studies of lands within KSC have been carried out. The earliest and most geographically comprehensive was the work of George A. Long, a University of Florida graduate student. Beginning in 1965, Long visited, examined, and recorded over 50 prehistoric and historic period archaeological sites within the KSC and Cape Canaveral (then Cape Kennedy). Most of the sites visited were noted in previously published accounts or reported by local residents and amateur archaeologists. Long also examined areas of construction activity plus locales deemed as "likely Indian habitation areas" (Ref. 4). Long's thorough description of site features and accurate site locational information provided a valuable body of data for future investigators.

The consultant team of Archaeological Consultants, Inc. (ACI), Sarasota, Florida, between 1990 and 1996, conducted a KSC-Wide Archaeological Survey. The objective of this project was to establish differential Zones of Archaeological Potentials (ZAPs) within KSC and to relocate and evaluate all the known or recorded sites on KSC to determine if they might be eligible for listing. In addition, in 1996, a historical/architectural survey of the Industrial Area, LC-39, VAB, and SLF areas, including 322 NASA-controlled facilities located within the LC-39 *NRHP* Site boundaries, plus 374 facilities located outside the boundaries was conducted (Ref. 5). Included were a variety of facility types, from temporary buildings and trailers to the VAB and LCC. All facilities were evaluated in accordance to the eligibility criteria for listing in the *NRHP*. Significant historic properties identified were included in a *NRHP* Multiple Property nomination. A similar methodology was used to conduct a historical/architectural survey of 106 NASA-owned facilities located within CCAFS (Ref. 6).

12.3.2 ARCHAEOLOGICAL SITES ON KSC

Based on the KSC-wide predictive model survey completed in 1996, the number of known archaeological resources included 100 sites (located west of Mosquito Lagoon). The significance of most of these previously and newly recorded sites has been assessed in accordance with the National Register eligibility criteria. The 100 known sites contain a total of 116 identified temporal/cultural components, of which 91 (78.4 percent) are prehistoric and 25 (21.6 percent) are historic as follows:

12.3.2.1 Prehistoric. The 91 prehistoric components can be classified into six site types: artifact scatters, shell middens, middens, burial mounds, lithic scatters, and single artifact occurrences. Five sites are unknown as to type.

Artifact Scatters (AS): The most commonly recorded site type is the artifact scatter. Thirty such resources have been recorded within KSC. These are generally characterized by a low- density distribution of aboriginal pottery vessel fragments (sherds), and may also include chipped stone tools, debris from stone tool manufacture and/or modification (waste flakes, lithic debitage), shell tools, shell food remains, and/or animal bone. At KSC, most artifact scatter-type sites are located along sandy ridges proximate to a fresh water source such as a creek, swamp, or slough.

These resources are generally visible, small discrete surface scatters of cultural materials. Many have been recorded in areas disturbed by prior agricultural activity.

Shell Middens (SM): This type of aboriginal site occurs with the second greatest frequency. Twenty-five shell middens representing 27.5 percent of the known site-type components have been recorded. These resources are usually characterized by shellfish food remains in a matrix of dark, organically-enriched soil in association with aboriginal pottery, animal bone, shell tools, and other cultural materials. Typical shellfish species include oyster (*Crassostrea virginica*), hardshell clam (*Mercenaria sp*.), crowned conch (*Melongena corona*), and left-handed whelk (*Busycon sp*.). Most of the shell middens recorded within KSC are located along the shoreline of Mosquito Lagoon. A native vegetative cover of live oaks, cabbage palms, and cedars usually marks them. The results of archaeological testing at many of these sites indicate deep deposits, in some cases extending below the present water table.

Burial Mounds (BM): Eleven burial mounds have been recorded within KSC, representing 12.1 percent of the known site-type components. These aboveground sites range from small, circular features of low relief (1 m [3.3 ft]), to large sand tumuli measuring more than 10 m (32.8 ft) in height. Some burial mounds are recorded in pairs; others have associated living areas characterized by shell middens or "shell fields." The recorded burial mound sites are generally located proximate to either Mosquito Lagoon or Indian River. Where not impacted by modern land-altering activities, they are marked by oak/cabbage palm hammock vegetation. With the exception of the Ross Hammock burial mounds (two), little is known about the contents and temporal/cultural affiliations of these sites. Burial mounds can be expected to contain the remains of multiple individual interments, usually associated with grave goods including ceramics and other cultural materials.

Middens (MID): Ten middens representing 11.0 percent of the known site-type components are recorded within the KSC. Unlike the aboveground shell middens, these sites, often referred to as "black earth middens," are characterized by buried cultural deposits of shellfish food remains, shell tools, faunal remains, ceramics, and other cultural materials in a matrix of organically-enriched dark soil. These sites are not as rich and dense as the shell middens. Most of these sites are located on well-drained, low ridges inland from the shores of Mosquito Lagoon or the Indian River, as well as proximate to tributary creeks.

Single Artifacts (SA): Eight single artifact-type sites are recorded within KSC. These represent 8.8 percent of the known site-type components. Typically, this site-type is represented by one piece of aboriginal pottery or more typically a single lithic artifact. They have been found in the droughty sandhills areas, as well as on low ridges proximate to a fresh water source.

Lithic Scatters (LS): Only two lithic scatter-type sites are recorded within KSC. The relative scarcity of this site-type is undoubtedly associated with the absence of locally available stone suitable for tool manufacture. Each of the recorded lithic scatter sites was evidenced by a small quantity of chipped stone debris (debitage) resulting from the manufacture and/or modification of tools. Given the small sample size, typical environmental associations for this site-type cannot be determined at this time.

Unknown (UNK): Five recorded sites are of unknown type. Included in this category are two "villages" of unverified location recorded on the basis of a 16th century historical account (Mexia). The other three unknown site-types are also resources of unverified location.

12.3.2.2 Historic. The 25 historic components include 14 historic refuse deposits (**HR**), six cemeteries (**CEM**), and five miscellaneous (**HIS**) "other" types including a fort, canal, saltworks, homestead/grove, and sugar mill ruins. These are found in all portions of KSC.

12.4 SIGNIFICANT HISTORIC BUILDINGS, STRUCTURES, OBJECTS, AND DISTRICTS

12.4.1 HISTORIC FACILITIES SURVEY AND REASSESSMENT OF THE LAUNCH COMPLEX 39 (LC-39) SITE

In 1996, an assessment survey of NASA-controlled facilities within the Industrial Area, LC-39, Vehicle Assembly Building (VAB), and Shuttle Landing Facility (SLF) was performed by ACI (Ref. 5). Also included in this project was a reassessment of the *NRHP*-listed LC-39 Site (8BR172).

In 1973, LC-39 became the first NASA site at KSC to be listed in the *NRHP*. The nomination, which highlighted the national significance of those principal facilities associated with the Apollo Manned Lunar Landing Program, was prepared the previous year by George M. Hawkins, Chief of the Documentation and Data Management Branch of NASA/KSC. LC-39, built between November 1962 and October 1968, was evaluated as significant in the areas of architecture, communications, engineering, industry, science, transportation, and space exploration.

As originally defined, the boundaries of the National Register site encompass a rectangle measuring approximately 2,833 ha (7,000 ac) in areal extent. The significant structures comprising the *NRHP* site, as enumerated in the nomination form, include the VAB, Launch Control Center (LCC), three Launch Umbilical Towers (LUTs), a Mobile Service Structure (MSS), two Missile Crawler Transporter Facilities (Crawlers), the Crawlerway, and Launch Complexes A and B, the latter of which are comprised of the elevated launch pads, storage tanks, and associated servicing and control equipment. Although additional KSC facilities, including those in the Industrial Area, actively supported the Apollo Program, none was included in the *NRHP* Site.

Three hundred and twenty-two (322) NASA-controlled facilities are located within the original *NRHP* LC-39 Site boundaries. Of these, 207 (64 percent) were built and/or sited after the LC-39 Site was listed in the National Register, including a significant number (N=97) of temporary buildings and trailers. In addition, among the facilities cited in the original LC-39 Site nomination, the MSS is no longer extant, and one of the Launch Umbilical Towers (LUT) has been dismantled. In summary, the majority of individual facilities within the existing 2,833 ha (7,000 ac) *NRHP* Site are not associated with the historically important events of the Apollo Program; are not dated to the period of significance for the historic property (1961-1975); are not distinguished for their historical, engineering and/or architectural values; and/or have suffered a substantial loss of integrity, which makes them no longer eligible for *NRHP* listing.

12.4.2 A MULTIPLE PROPERTY APPROACH TO SIGNIFICANT HISTORIC PROPERTIES

A Multiple Property nomination was selected as the most appropriate means by which the significant properties identified could be nominated to the National Register. Information common to the group of properties is presented in the Multiple Property Documentation Form (the "cover" nomination), which was prepared and submitted under separate cover, while information specific to each individual building, site, structure, object, or district was placed on the individual registration forms, also submitted with the Multiple Property cover. An advantage of this approach is that the Multiple Property nomination, which groups related significant properties, facilitates the evaluation of individual properties by comparing them with resources that share similar physical characteristics and historical associations. In addition, the Multiple Property nomination is a flexible document permitting additional contexts and resources to be added as they become eligible.

The *NRHP* submission took a thematic approach focusing on the Apollo era Manned Space Program as an exceptionally important historic event and the KSC facilities, which best represent it. The period of significance spans 1961 through 1975, from the time of initial preparations to the last operational flight. Today, many original Apollo era facilities are in active use supporting the Space Shuttle Program. Some facilities have been altered to support this program, while others have been discarded or dismantled. Registration requirements were, therefore, structured to accommodate these considerations particularly with regard to the issue of integrity.

12.4.3 CONTRIBUTING AND NON-CONTRIBUTING RESOURCES

Individual nominations comprising the Multiple Property submission, ***Historic Cultural Resources of the John F. Kennedy Space Center, Florida***, fulfill Criteria A, B, and/or C for listing in the *NRHP*. The properties included have exceptional significance for their association with events or individuals nationally important in the areas of space exploration, communication, engineering, and transportation. Properties eligible for listing under the cover were constructed between 1961 and 1975. The nominated resources include five buildings (VAB, LCC, CIF, O&C, and Headquarters), three structures/objects (Crawlerway, Press Site: Clock and Flagpole, Crawlers), and two districts (LC-39: Pads A and B). They are categorized into the following six associated property types: transportation facilities, launch processing facilities, launch operation facilities, press facilities, communication facilities, and administrative facilities.

Individual nominations were formed under the Multiple Property cover for 10 historic facilities:

- Vehicle Assembly Building (VAB) - High and Low Bays (8BR1684)
- Launch Control Center (LCC) (8BR1685)
- Crawlerway (8BR1689)
- Press Site: Clock and Flag Pole (8BR1690)
- Missile Crawler Transporter Facilities (Crawlers) (8BR1688)
- Launch Complex 39: Pad A (8BR1686)
- Launch Complex 39: Pad B (8BR1687)
- Headquarters Building (8BR1691)

- Central Instrumentation Facility (CIF) (8BR1692)
- Operations and Checkout (O&C) (8BR1693)

A summary statement of significance for each individually eligible property follows:

The **VAB High and Low Bays**, considered as one building, is significant at the national level under Criterion A (a property that is associated with events that have made a significant contribution to the broad patterns of our history) in the area of space exploration. The VAB is also significant under Criterion C (property embodies the distinctive characteristics of a type, period, or method of construction or represents a significant and distinguishable entity whose components lack individual distinction) under engineering and invention. Because this structure has achieved significance within the past 50 years and is of exceptional importance in the areas of space exploration, invention, and engineering, Criteria Consideration G also applies.

The VAB was designed to house the Saturn rockets of the Apollo mission. Through its function as a building, which houses the assembly, test, checkout, and protective storage for launch vehicles and spacecraft, the VAB played an integral part in the Apollo program. Built in 1966, it had to be large enough to hold the 110 m (363 ft) tall Apollo/Saturn V vehicles. As a result, the VAB is one of the world's largest buildings by volume and was considered the largest when it was built. It covers a ground area of about 3.24 ha (8.0 ac) and has a volume of approximately 3.88 million cubic meters (129.48 million cubic feet). The VAB is 160 m (525 ft) tall, 218 m (716 ft) long, and 158 m (518 ft) wide. Therefore, its engineering, design, and innovation are exceptionally important. The VAB has substantially retained its integrity of design, materials, workmanship, feeling, setting, location, and association, which made it vital to the Apollo program.

The **Launch Control Center (LCC)**, built in 1965, is also significant under *NRHP* Criteria A and C; Criteria Consideration G also applies. As the building designed to control the prelaunch and launch operations of the Saturn V and Saturn IB vehicles, it was vital to the operation of the Apollo Program. Although modified with updated technology, the LCC has substantially maintained its integrity of design, materials, workmanship, feeling, setting, location, and association, as an intact resource still performing its vital operation as the "brain" of Launch Complex 39. Designed in the International Style, the four-story LCC largely retains the same configuration as when constructed. The reinforced concrete building measures 117 m (385 ft) tall, 51 m (166 ft) wide, and 23 m (76 ft) high. It originally contained four main firing control rooms, various offices, shops, laboratories, storage rooms, and personnel facilities. Today, the LCC contains two primary and one backup firing rooms, each equipped with the Launch Processing System, which monitors and controls Shuttle assembly, checkout, and launch operations.

The **Crawlerway**, built in 1964, is a unique dual-lane roadway designed for carrying the Crawlers and their loads from the VAB to LC-39 Pads A and B. These roadways are 39.6 m (130.0 ft) wide with twin 12 m (40 ft) wide river rock-covered lanes called trackways, which are separated by a grass median 15 m (50 ft) wide. The Crawlerway is constructed in four layers: a top layer of river gravel about 20 centimeters (cm) (8 in) thick on curves and 10 cm (4 in) on straightaway sections, underlain by successive strata of graded, crushed stone 1.2 m (4.0 ft) in thickness; 0.76 m (2.5 ft) of select fill; and 0.3 m (1.0 ft) of compact fill.

The Crawlerway stretches 5.4 km (3.4 mi) from the VAB to Pad A and 6.7 km (4.2 mi) to Pad B (Ref. 7). The portion of the Crawlerway located west of the VAB was altered ca. 1985 with the placement of modular office buildings, trailers, and a parking lot on top of the Crawlerway. Although the original engineering and materials remain intact below ground, the Crawlerway's integrity has been compromised in this location. The Crawlerway is significant at the national level under Criteria A and C and meets Criteria Consideration G.

The **Press Site: Clock and Flag Pole**, built ca. 1969, functions as the primary site for news media activities at the KSC. The countdown clock marks the time to liftoff; both the clock and flagpole flying the U.S. flag comprise optional media foreground during the countdown sequence and liftoff (Ref. 7 & 8). Although the interior clock mechanism has been changed, the exterior of the clock is original to the Apollo era as is the flagpole. The careful positioning of the clock and flagpole in the direct sightline of the launch enabled broadcasters to feature these objects during countdown and liftoff. Consequently, they are historically associated with the Apollo era launch procedures in the collective mind of the public, which witnessed the worldwide broadcasts. The Press Site: Clock and Flag Pole are significant at the national level under *NRHP* Criterion A and meet Criteria Consideration G. These historic objects largely retain their integrity.

The two **Mission Crawler Transporter Facilities** ("**Crawlers**"), built in 1965, were used during the Apollo era to transport the Mobile Launch Umbilical Tower, including the Launch Vehicle, from the VAB to Launch Pads A or B and return the LUT to the VAB after launch. They were also used to transport the Mobile Service Structure from its park area to-and-from the pad. At the time of construction in 1965, by the Marion (Ohio) Power Shovel Company, the Crawlers were believed to be among the largest tracked vehicles in the world (Ref. 8, 9, and 10). The two Crawlers are about 6 m (20 ft) high, 40 m (131 ft) long, and 35 m (114 ft) wide. Each one weighs about 2.7 million kilograms (5.9 million pounds) unloaded. A Crawler has eight tracks, each of which has 57 shoes or cleats. Each shoe weighs approximately 907 kilograms (1 ton). As the only two vehicles of their type in the United States, they represent a unique mode of transportation, which was integral to the success of the lunar missions. The Crawlers are significant at the National level under Criteria A and C and meet Criteria Consideration G. They have each substantially retained their integrity.

The **Headquarters Building**, constructed in 1965, was designed as the Administrative Center for KSC. It was essential to the Apollo Program where all major decisions and meetings were conducted. Stylistically, the Headquarters Building is representative of the International Style. The building was designed so that it could be enlarged incrementally. In 1968, two new wings, to the east and the west, were constructed. These new wings mirrored the original structure and increased its overall length to nearly 274 m (900 ft) across the front. Although the interior has been modified, the 40,689 square meter (439,446 square foot) Headquarters Building still retains the same configuration as in 1968, and continues to function as the Administrative Center for KSC housing many contractor and NASA offices (Ref. 8). It is significant at the National level under Criteria A and C and meets Criteria Consideration G. It has substantially maintained its integrity of design, materials, workmanship, feeling, setting, location, and association.

The **Central Instrumentation Facility (CIF)**, built in 1965, was originally the hub of instrumentation and data processing operations. It provided instrumentation to receive, monitor, process, display, and record information received from the space vehicle during test, launch, and flight. This three-story structure was designed in the International Style. The building itself has remained essentially unaltered, except for small, ca. 1970, one-story room additions on the south and east elevations (Ref. 10, 11, and 12). The CIF is significant at the National level under Criteria A and C and meets Criteria Consideration G. The building was designed especially to house and control the computer and communications networks of the Apollo Program. It was essential to the success of the program.

The **Operations and Checkout Building (O&C)**, built in 1964, was used for assembly and checkout of the Apollo spacecraft modules and also provided crew training and preflight preparations (Ref. 9). This five-story building, designed in the International Style, is the largest facility in the Industrial Area. Within two years of its construction, massive extensions were made to the north and south wings. The building contained astronaut housing, laboratories, medical facilities, and the Apollo mission high-altitude chambers, which were used to assemble and test the integrated command, service, and docking modules in a simulated space environment (Butowsky 1981:11). One of the altitude chambers was moved to Hangar L in 1985 and has been extensively altered. Because it is no longer located in the O&C, it is not considered a contributing component of this resource. However, the altitude chamber, which remains in the O&C continues to contribute to the significance of this building despite some alteration to house the Vertical Access Simulator. This altitude chamber, the astronaut quarters, and the specialized features designed to house computers and electronic equipment are unique elements, which support the significance of this property. This building retains a substantial amount of integrity and is considered significant under *NRHP* Criteria A and C and also meets Criteria Consideration G. It is still in active use, and has been reconfigured to accommodate the needs of the Space Shuttle Program.

In addition to these individually eligible historic properties, both **LC-39 Pads A and B** were nominated to the *NRHP* as historic districts, each comprised of numerous contributing properties. In general, the resources are considered to be contributing to their respective districts, because they were present during the period of significance (1961-1975). Collectively, they relate to the launch of the Apollo missions or to the understanding of the mission of KSC by the American public. All retain enough integrity to communicate their relative significance within the context of the Apollo Program. Individually, however, no one resource is considered to independently meet the *NRHP* eligibility criteria.

Both launch pads are octagonal in shape and virtually identical in size, each covering about 0.65 square kilometers (0.25 square miles) of land. The distance between the two pads is 2,657 m (8,715 ft). Each pad base required 52,000 cubic meters (68,000 cubic yards) of concrete. The two pads have been heavily modified from their Apollo/Saturn V configuration to launch Space Shuttles. The upper portions of two of the three Saturn V LUTs were removed from the Mobile Launchers (which became Mobile Launcher Platforms, or MLPs, after this and other changes) and installed at each pad to become Fixed Service Structures (FSSs). A Rotating Service

Structure (RSS), which replaced the movable gantry was built at each pad. The movable Saturn V flame deflector in each flame trench was replaced with two joined and anchored Shuttle flame deflectors.

The **LC-39: Pad A** was constructed in 1965 as one of two sites able to successfully launch manned lunar missions. Pad A was the site of the first Saturn V launch and also served the Apollo 11 mission in 1969, which took Armstrong, Aldrin, and Collins to the moon. Pad A was specially constructed to withstand the weight of the Saturn V rockets and later modified for the weight and additional heat and sound of the Space Shuttle. Therefore, it is significant as an engineering and design masterpiece (Ref. 10). The pad is significant at the National level under Criteria A and C and meets Criteria Consideration G.

Although not all facilities at Pad A are considered significant, all structures within and immediately adjacent to the Perimeter Road are considered to be within the district boundaries. Twenty-four (24) contributing resources, built between 1964 and 1968, are located within this boundary, as well as 39 non-contributing resources. Non-contributing facilities, constructed between 1979 and 1996, include 24 trailers and temporary buildings (boxcar complexes), which date to between 1978 and 1985.

The **LC-39: Pad B**, built in 1966, saw the liftoff of several Apollo missions including Skylab and Apollo-Soyuz. It has been extensively modified, like Pad A, to accommodate Space Shuttle launches. Considered significant under *NRHP* Criteria A and C, the LC-39 Pad B district includes 23 contributing properties built between 1967 and 1968, as well as 34 non-contributing resources dated from 1980 to 1995, including 20 trailers and temporary buildings.

12.5 REFERENCES

1. Milanich, Jerald T. 1994. *Archaeology of Precolumbian Florida*. University Press of Florida, Gainesville.

2. Rouse, Irving 1951. A Survey of Indian River Archeology, Florida. *Yale University Publications in Anthropology,* Number 44. New Haven.

3. Advisory Council on Historic Preservation (ACHP) 1995. *Consideration of Highly Technical and Scientific Facilities in the Section 106 Process* (DRAFT). Washington, D.C.

4. Long, George A. 1967. Indian and Historic Sites Report, John F. Kennedy Space Center, NASA.

5. Archaeological Consultants, Inc. 1998. Survey and Evaluation of the Historic Facilities within the Industrial, Launch Complex 39 (LC-39), Vehicle Assembly Building (VAB), and Shuttle Landing Facility (SLF) Areas of the John F. Kennedy Space Center (KSC), Brevard County, Florida, with a Reassessment of the Existing National Register of Historic Places LC-39 Site.

6. Archaeological Consultants, Inc. 2001. Survey and Evaluation of NASA Facilities Within the Cape Canaveral Air Force Station.

7. National Aeronautics and Space Administration (NASA) 1992. *Master Plan: John F. Kennedy Space Center* (Volume I). October.

8. Anon. 1994. *Facts: John F. Kennedy Space Center*.

9. Butowsky, Harry A. 1981. *Reconnaissance Survey: Man in Space*. U.S. Department of the Interior, National Park Service, Washington, D.C. November.

10. National Aeronautics and Space Administration (NASA) 1967. *Technical Facilities Catalog Volume II* [NHB 8800.5 (II)]. March.

11. National Aeronautics and Space Administration (NASA) 1974. *Technical Facilities Catalog Volume II* [NHB 8800.5A (II)]. October.

12. National Aeronautics and Space Administration (NASA) n.d. *Facilities Handbook*. Washington, D.C.

SECTION XIII

SOCIOECONOMICS

13.1 WORKFORCE

KSC is Brevard County's largest single employer and a major source of revenue for local firms. KSC's operations cause a chain of economic effects throughout the region. It is estimated that each job created within Brevard County's space industry generates an additional 1.93 jobs within this region. KSC's reciprocal relationship with Brevard County has far-reaching effects. KSC is directly and indirectly involved in many Florida industries that supply goods and services to the Space Program and various other NASA projects. Additionally, KSC supports two industries generated by KSC's own resources:

- *Agriculture and Aquaculture*: The Fish and Wildlife Services (FWS) manage approximately 325 hectares (800 acres) of citrus groves on the Merritt Island National Wildlife Refuge (MINWR). This is managed though a leasing agreement with the Kerr Center and is researching the concept of sustainable agriculture. Commercial fishing for oysters, shrimp, and other river fish species is permitted within the MINWR and Canaveral National Seashore (CNS) areas.

- *Tourism*: KSC's Visitor Center Complex is a popular tourist attraction drawing thousands of people every day, providing the public with a first-hand look at the latest technology. MINWR and CNS areas are additional attractions and popular parks for swimming, hunting, fishing, bird watching, boating, and other forms of eco-tourism.

Few places have experienced such sudden and far-reaching impacts, as did Brevard County, when the Federal Government decided to establish the Eastern Test Range in this locale. There were approximately 14,044 personnel employed at KSC at the end of September 2002. This population includes contractor, construction, tenant, and permanent civil service employees. Approximately 13 percent of the total workforce is considered civil service employees. A summary of KSC personnel levels since 1964 is provided in Table 13-1.

The highest employment levels at KSC were recorded during the Apollo Program. In 1968, a peak population of 25,895 was recorded and an estimated one in four workers in Brevard County were employed by operations at KSC. Employment levels dropped precipitously following the Apollo Program to a historic low in 1976, when a total of 8,441 personnel were employed. Employment levels rose sharply in 1979, when KSC was designated as the Launch and Operations Support Center for STS (see Table 13-1). Employment levels have gradually risen through 1985, following the increasing number of launch events. Another sharp drop in employment levels was seen in 1986, as a result of the loss of the Space Shuttle Challenger.

Approximately 46 percent of the estimated 14,044 personnel at KSC have positions directly related to STS and payload processing operations. The remaining workforce is employed in ground and base support, unmanned launch programs, crew training, financial and resources management, engineering and technology development, safety, health, and independent assessment, research and development, and administrative positions. The largest concentration of personnel (approximately 49 percent of the KSC workforce) is stationed in the VAB area. The Industrial Area is the next most populated area with approximately 5 percent of the KSC workforce. The remaining personnel are stationed at various outlying facilities at KSC and at CCAFS.

Table 13-1. History of Workforce at Kennedy Space Center.

End Fiscal Year (Sept.)	Number of People	Year Change
1964	11,230	4,879
1965	16,819	5,589
1966	18,482	1,663
1967	24,404	5,922
1968	25,895	1,491
1969	23,620	-2,275
1970	16,235	-7,385
1971	14,470	-1,765
1972	14,642	172
1973	12,841	-1,801
1974	9,246	-3,595
1975	10,368	1,122
1976	8,441	-1,927
1977	9,376	935
1978	10,352	976
1979	13,002	2,650
1980	13,688	686
1981	14,004	316
1982	14,391	387
1983	14,665	274
1984	15,133	468
1985	16,067	934
1986	13,664	-2,403
1987	15,307	1,643
1988	16,559	1,252
1989	18,151	1,592
1990	18,522	401
1991	19,088	536
1992	18,696	-392
1993	18,253	-443
1994	16,585	-1668
1995	16,413	-172
1996	16,208	-205
1997	14,593	-1,615
1998	14,200	-393
1999	13,123	-1.077
2000	14,716	1,593
2001	13,499	-1,217
2002	14,044	545

13.2 TRANSPORTATION RESOURCES

13.2.1 ROADS

Highway transportation routes are shown in Figure 13-1. KSC is serviced by over 340 km (211 mi) of roadway with 263 km (163 mi) of paved roads and 77 km (48 mi) of unpaved roads. Of the five access roads onto KSC, NASA Parkway West serves as the primary access road for cargo, tourists, and personnel entering and leaving. This four-lane road originates in Titusville as State Road 405 and crosses the Indian River Lagoon onto KSC. Once passing through the Industrial Area, the road reduces to two lanes of traffic. It then crosses the Banana River and enters unto CCAFS. The third point of entry onto KSC is from the south via South Kennedy Parkway, which originates on north Merritt Island as State Road 3. This road is the major north-south artery for KSC and is also a four-lane highway. The fourth entry point is accessible from Titusville along Beach Road, which connects to North Kennedy Parkway. The final access point is south of Oak Hill at the intersection of U.S.1 and North Kennedy Parkway. All roads to KSC have control access points, which are manned 24-hours per day, 7-days per week. Design standards for primary roads and highways mandate 24-ft widths and for two-lane roads, a 40-ft wide median strip. All paved roads conform to the American Association of State Highway and Transportation Specification H20-S16. This specification establishes a load bearing capacity of 20 tons for a tractor truck and a gross single axle weight of 16 tons (8 tons/wheel).

13.2.2 RAIL

A railroad spur runs from the Florida East Coast rail line to KSC (see Figure 13-1). The spur spans the Indian River and Intracoastal Waterway via a causeway and bascule bridge from Wilson, on the mainland, to Merritt Island. Approximately 65 km (40 mi) of rail track provides heavy freight transportation to KSC.

13.2.3 WATERWAYS

Port Canaveral is the nearest navigable oceanic connection to KSC. Navigable access from Port Canaveral to KSC docking facilities at Hangar AF (CCAFS) and the Barge Turning Basin is provided by 31 km (19.3 mi) of maintained channels. The docking facilities at Hangar AF Wharf are used primarily in the retrieval of the SRB motors following launches. The Turning Basin Wharf is used to unload the external fuel tanks of the STS and other heavy equipment suited to waterway transport. A total of 481 m (1,578 ft) of dockage is available at the existing wharf facilities.

13.3 SERVICES

13.3.1 SECURITY

Security operations including access control, personnel identification, traffic control, law enforcement, investigations, classified material control, and national resource protection are

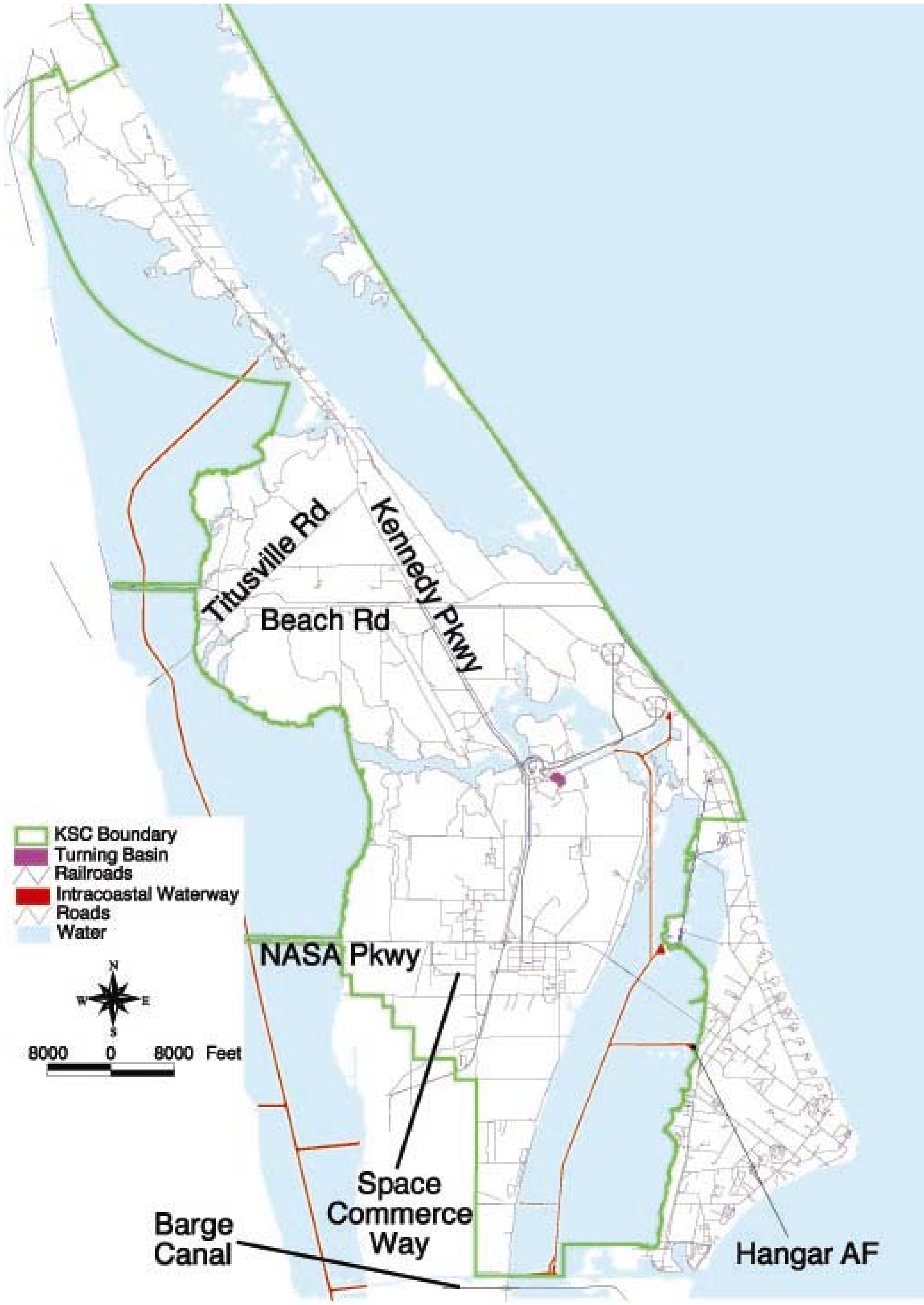

Figure 13-1. Transportation Routes on Kennedy Space Center.

provided by SGS/J-BOSC at KSC/CCAFS. The security forces maintain road access control gates and patrol the KSC/CCAFS perimeter boundaries.

KSC/CCAFS security forces have coordination agreements to support local municipalities in the event of an emergency or disaster. Requests for emergency support are directed through the Brevard Civil Defense Coordinator to the KSC Emergency Preparedness Office.

13.3.2 FIRE PROTECTION

Fire protection at KSC/CCAFS includes a comprehensive program of fire protection engineering, fire prevention, fire suppression and emergency response operations. Specialized equipment and training, suited to the potential fire and emergency hazards of operations at KSC are provided. Three Fire Stations, two located in the VAB Area and one located in the Industrial Area provide effective coverage for all of KSC/CCAFS. Coordination support agreements between KSC/CCAFS and local municipalities provide for reciprocal support in the event of an emergency or disaster.

13.3.3 HEALTH

An Occupational Health Facility and an Emergency Aid Clinic provide medical services to KSC/CCAFS. These facilities are staffed by medical personnel specially trained in the hazards and treatment associated with the facilities and operations at KSC/CCAFS. The medical facilities are equipped to provide first-care treatment of injuries. Ambulance service and a medically equipped helicopter are available to transfer injured personnel to full-care medical facilities. KSC/CCAFS have established Memoranda of Understanding for emergency treatment with the following medical facilities: Jess Parish Medical Center, Cape Canaveral Hospital, Wuesthoff Memorial Hospital, Brevard County Civil Defense & Emergency Medical Services, Patrick Air Force Base Hospital, Orlando Regional Health Systems, Florida Hospital, and Holmes Regional Medical Center.

13.4 SURROUNDING COMMUNITIES

Brevard County was established in 1844 from a portion of Mosquito County and was originally named St. Lucie. In 1855, the name was changed in honor of Theodore Washington Brevard (1804-77) of North Carolina. Brevard came to Florida in 1847 and became the State Comptroller. Brevard County is bordered by the Atlantic Ocean and by Volusia, Orange, Osceola, and Indian River counties. The county has 631 square kilometers (299 square miles) of water. Most of Brevard County's population resides along the Indian River and the Atlantic Ocean. In 1993, the most populous incorporated areas were Palm Bay (69,197 persons), followed by Melbourne (64,191 persons), and Titusville (40,679 persons). Cocoa, Rockledge, and Cocoa Beach all had populations in excess of 10,000 in 1993. The unincorporated area of Merritt Island, sparsely populated in 1960, had a population of 32,886 in 1990. During the 1980’s, Port St. John, between Titusville and Cocoa, and Micco, south of Melbourne, developed rapidly. The U.S. Bureau of the Census has designated Brevard County as the Melbourne-Titusville-Palm Bay Metropolitan Statistical Area. In 2000, 87 percent of Brevard County's population was white and 13 percent was nonwhite. In 2000, 4.6 percent of the population was

Hispanic. Of the population increase between 1980 and 1990, 87.7 percent was due to net migration. The 1992 birth rate for the county was 13.2 live births per 1,000 persons, and the 1992 death rate was 9.3 deaths per 1,000 persons. In 1992, the infant mortality rate was 6.9 per 1,000. The leading causes of death in 1993 were heart disease, cancer, and chronic obstructive lung disease.

The per capita income for 1993 was $19,321 (18th highest in the state). The median household income in 1989 was $30,534. In 1989, 6.3 percent of families had incomes below the poverty level. In 1990, 17.7 percent of personal income was derived from transfer payments. Electrical equipment and supplies and transportation equipment firms account for the most employment in the manufacturing sector. In 1992, there were 496 farms in Brevard County, totaling 80,825 ha (199,724 ac), 31percent of land in the county. Leading agricultural products include cattle and citrus. In 1991, 1,967,992 kilograms (4,338,679 pounds) of fish and 698,177 kilograms (1,539,218 pounds) of shellfish were landed in Brevard County.

City of Cape Canaveral: A tiny 4.9 square-kilometer (1.9 square-mile) town sandwiched between the Atlantic Ocean and the Banana River. Cape Canaveral has a population of 8,337. Rich with history, Cape Canaveral is reportedly the oldest named place in the country. Ample housing, shopping and other amenities complete the area. Cape Canaveral Elementary School serves the area's children educational needs. Port Canaveral, to the north of the city, is the third largest cruise-passenger port in the country. Port Canaveral is a vital import/export-shipping center. The Port has the largest dockside refrigerated storage facility in the country. As Foreign Trade Zone #136, Port Canaveral encompasses 1684 hectares (4,160 acres) of land. The Foreign Trade Zone status lowers U.S. production costs and offers savings to export companies. The Port is a major deep-water port of entry with 9 cargo berths, 46,452 square meters (500,000 square feet) of warehouse and dry cargo storage, and commercial fishing fleets.

City of Cocoa: Bordered by the Indian River to the east, Cocoa extends west to undeveloped hammock areas. An old established city, Cocoa features large restored, southern homes along scenic river roads. Cocoa is an old city with a historic downtown area. The city, first settled in the 1860's, derived its name from a shipment of baker's cocoa to the local store in the 1880s, and has grown into a bustling community with a population over 17,000. Cocoa is home to some of Florida's major fruit shippers and the Brevard Community College (BCC) main campus. Courses are offered in academics, technical, vocational, continuing education and adult community education subject. The University of Central Florida, which maintains a branch at BCC, offers graduate and upper division courses as well. Students can earn baccalaureate and master's degrees in engineering, nursing, education and technical areas without leaving the county. Schools and housing are conveniently located near one another. Cambridge Elementary's "High Scope Preschool Program" was recognized by the U.S. Department of Education. Two causeways connect Cocoa with Merritt Island and the beaches. West Cocoa includes the St. John's River, a freshwater fisherman's delight. Commercial and private boaters launch their water vehicles from the waterway.

City of Cocoa Beach: An island community known for its attractive beaches, Cocoa Beach offers 19 km (12 mi) of public beaches complete with hotels, boat rentals, deep-sea fishing opportunities and other water sports. The city's residential areas house many of the Space

Program's engineers, astronauts and technicians. Single-family homes, condominiums and apartments are available on the ocean, river and in between. A Space Congress of scientists from the U.S. and Europe meets each spring in Cocoa Beach to review events and new technology.

City of Rockledge: Rockledge was first settled in 1837, making it the oldest resort on Florida's east coast and Brevard County's oldest city. In the late 1800s, Rockledge was a popular resort town, featuring three stores, two sawmills, several schools, and a church. It is named for the coquina rock formations extending into the Indian River. Today, Rockledge is known for both its restored riverfront homes and new housing developments. A comprehensive Land Use Plan adopted in 1975 limits development in the city to 5 single-family or 14 multi-family units per acre. Growth in Rockledge was fairly slow until the Space Program in the 1950s. Since then, the economy has diversified into such areas as manufacturing and building supply industries.

City of Titusville: Situated on the Indian River, near the Atlantic Ocean, Titusville is the "Gateway" to KSC. The greater Titusville area population is now over 40,000 people. Titusville is the home for many of the employees and contractors of NASA. Because of the many highly trained professionals, including engineers and technicians, Titusville has one of the highest median incomes in Central Florida. The Space Center Executive Airport, with access for private and corporate aircraft, is situated between the Space Center and Spaceport Florida Industrial Park. In addition to its industrial and technological centers, Titusville has numerous residential areas. Housing prices range from moderate to high. Titusville receives high marks for its educational and cultural offerings. Serving the area are Astronaut and Titusville High Schools, plus two middle schools and seven elementary schools.

Merritt Island Community: Merritt Island is 64 km (40 mi) long and varies from 11 km wide (7 mi wide) at the north to 3 km wide (2 mi wide) at the south. Most of the Island's population occupies a suburban area of middle-class homes between State Roads 528 and 520, where prices range from the low $50,000 to the mid $100,000. Merritt Island is the home of hundreds of businesses, stores, restaurants, real estate and mortgage companies, banks and Government offices. There is a light industrial section and an airport south of SR 520. To the south of SR 520, the Island's width thins and the area is again residential. North of SR 528 is KSC. Merritt Island recreational areas are the 35-square km (22-square mi) MINWR, the 6-ha (16-ac) Kiwanis Park and the 15-ha (38-ac) Rotary Park. Merritt Island High School, Jefferson and Edgewood Middle Schools and five elementary schools serve the area.

Port St. John Community: Port St. John is a relatively new community situated midway between Titusville and Cocoa. The current population of 16,649 is projected to grow to 19,655 by the year 2010. New and existing home prices range from the mid $50,000 to the mid $100,000, making the area an affordable choice for both retirees on fixed incomes and young families working in nearby cities. The business district in Port St. John includes mortgage companies, a bank, several restaurants, family medical centers and convenience stores. Three elementary schools and a middle school serve residents.

13.5 KSC COMMITMENT TO SURROUNDING COMMUNITIES

KSC is committed to ensuring that the goals of Executive Order 12898 and NASA's Environmental Justice Strategy are met. Moreover, KSC will continue to communicate with and

Table 13-2. 2000 Population Census Data of KSC Surrounding Communities.

	2000 Population Census Data					
Place Name	**Total**	**Caucasian**	**African American**	**Native American**	**Asian Pacific Islanders**	**Hispanic**
United States of America	281,421,906	211,460.626	34,658,190	1,959,234	10,641,833	35,305,818
State of Florida	15,982,378	12,465,029	2,335,505	53,541	274,881	2,682,715
Brevard County	476,230	413,411	40,000	1,765	7,457	21,970
Cape Canaveral City	8,829	8,359	126	28	155	307
Cocoa City	16,412	10,252	5,298	104	192	809
Cocoa Beach City	12,482	12,062	78	28	141	314
Merritt Island CDP	36,090	32,560	1,918	149	618	1,381
Mims CDP	9,147	7,919	1,004	58	22	141
Oak Hill City	1,378	1,127	224	9	3	9
Port St. John CDP	12,112	10,985	607	57	132	397
Rockledge City	20,170	16,349	2,952	56	352	662
Titusville City	40,670	34,080	5,142	160	399	1,430
Source: U.S. Census Bureau, American FactFinder, Quick Tables, DP-1, Profile of General Demographic Characteristics: 2000; Data Set: Census 2000 Summary File 1 (SF 1) 100-Percent Data.						

seek the input of local communities through public meetings, material distributions, information repositories, community events, open houses, press releases and public education campaigns. To ensure that members of the community are well informed of potential adverse environmental impacts from KSC activities, a mailing list with the names of local officials, community leaders, public interest groups, interested individuals, media, and community organizations was compiled. The mailing list is updated as changes are reported.

There are several outreach programs in which KSC is involved, thus furthering KSC's commitment to the community. These programs also involve outreach to KSC employees and contractors. Such programs include participating in:

- *Summer High School Research Apprentice Program (SHARP)* - this program is designed to encourage academically gifted and under-represented minority students to explore professions related to science, mathematics, and engineering
- *NASA's Unique Resident Tutoring for Up-and-Coming Replacement Engineers Program (NURTURE)* - this program supports and encourages students with an aptitude for science, engineering, and mathematics to explore and pursue careers in those disciplines
- *Science Engineering And Research Career Help Program (SEARCH)* - this program is designed to encourage, assist, and motivate minority and female students in grades 6-9 to pursue secondary and collegiate courses which will lead to careers in science, engineering, mathematics and technology
- *Annual Day of Caring Program* - this program allows KSC employees four hours off to help and provide assistance in the community work

- *Combined Federal Campaign (CFC)* - is the annual solicitation of employees in the Federal workplace on behalf of local, national, and international charitable organizations.
- A Teacher-Resource Internet Center - where local people can obtain materials on science, math, and related topics providing extensive information about NASA and KSC
- Annual *EARTH Day* (also known as *Environmental & Energy Awareness Week*) - Whether you celebrate Earth Day on the first day of spring or April 22, the important matter is to remember that every day is crucial where the health of the planet is concerned. This is an excellent time to learn about KSC's successes and learn what you can do to continue to foster environmental stewardship, energy conservation, and continual improvement through increased awareness. Reemphasizes your commitment to environmental leadership. Preserving our environment for future generations is everyone's responsibility. This is a chance for all of us to evaluate our activities by ensuring a safe and healthy work environment. EEAW strongly encourage you to participate in their events to learn how you can contribute to a stronger and cleaner America through environmental stewardship and energy conservation.
- *Take-Your-Children To Work Day* - it allows children between the ages of 13-15 to accompany their parents to work on a designated day and have an opportunity to observe and participate in some of the job functions in which they are involved. The main objective of "Take Our Kids To Work" is to foster an understanding between parent and child of what the parent does, and in so doing to build stronger family links.
- *African-American Heritage Month* - February is a time for all Americans to commemorate the rich and diverse contributions of African-Americans to the culture and history of the U.S.A. and to World. "Creating and Defining the African-American Community: Family, Church, Politics and Culture."
- *Hispanic Heritage Month* – promotes diversity awareness of multicultural issues at KSC through outreach activities; provides highly qualified Hispanic applicants for employment through contacts with community organizations and colleges and universities; provides Spanish speaking assistance or involvement; supports mentors for SHARP, NURTURE, intern programs and other student programs; participates in All American KSC Picnic, continues the HEPWG telephone system, and supports the cultural barriers identification team's efforts
- *Asian Pacific Islanders Heritage Month* – is to promote diversity and an understanding of AAPI cultures and working relationships within the NASA/KSC workforce; assists Public Affairs and the Security Offices with various language interpretations; and supports the surrounding communities
- *Native American Heritage Month* - celebrates Native American culture, educates the public, and acknowledges the contributions of Native Americans to society and KSC
- *National Disability Employment Awareness Month* - is designed to highlight the abilities and skills of those with disabilities

SECTION XIV

ENERGY

14.1 REGULATORY OVERVIEW

The following list includes relevant Federal statutes, Executive Orders, NASA Directives, and KSC requirements documents:

- 42 U.S.C. 8252, et seq., the National Energy Conservation Policy Act, as amended by the Energy Policy Act (P.L. 102-486, 106 Stat. 2776)
- EO 13123, dated June 3, 1999, Greening the Government Through Efficient Energy Management
- EO 13148, dated April 21, 2000, Greening the Government Through Leadership in Environmental Management
- EO 13221, dated July 31, 2001, Energy Efficient Standby Power Devices
- 10 Code of Federal Regulations (CFR) Part 436, Federal Energy Management and Planning Programs
- NASA Policy Directive (NPD) 8500.1, NASA Environmental Management
- NPG 8570.1, Energy Efficiency and Water Conservation Technologies and Practices
- Kennedy Documented Procedure (KDP)-KSC-S-2000 Rev: A 2/00, KSC Implementation Plan
- Kennedy Management Instruction (KMI) 8800.8B, KSC Environmental Management (Appendix B)
- Kennedy Handbook (KHB) 8800.6C, KSC Environmental Control Handbook (excerpts in Appendix C)

These directives drive energy conservation and cost reduction requirements. KMI 8800.8B and KHB 8800.6C document the NASA Agency Energy Mission Statement and KSC Energy Policy:

- NASA Agency Energy Mission Statement: Improving energy efficiency to save taxpayer dollars, reduce emissions contributing to air pollution and global climate change, and conserve precious natural resources for future generations.

- KSC Energy Policy: Energy efficiency is everyone's responsibility. All KSC organizations shall comply with Federal requirements and perform day-to-day activities as energy efficiency, as possible. For example, designing efficient equipment and facilities, buying efficient products, operating/maintaining equipment and facilities at peak efficiency, and turning off systems when not in use.

14.2 KSC ENERGY WORKING GROUP

In 1991, KSC established an Energy Working Group (EWG) to ensure KSC makes continual progress towards compliance with Federal energy efficiency mandates and reduces energy costs. Regarding energy matters, provide a forum to develop policies and plans, report progress and accomplishments, increase awareness, advocate/pursue initiatives and technology applications, forecast consumption/cost, and foster consistency across all Center elements."

14.3 PROGRAM OVERVIEW

KSC is a retail electricity, natural gas, fuel oil, and propane customer. JBOSC provides a monthly energy utilization/cost report that feeds NASA's accounting process to "direct charge" facility energy costs to the appropriate KSC program or tenant according to facility use. Each major program has its own facility engineering and operations & maintenance (O&M) contractor, but these contractors do not pay the energy bills. The JBOSC report also feeds the NASA Environmental Tracking System (NETS) for energy metrics reporting to Department of Energy (DOE), Office of Management and Budget (OMB), and Congress. Table 14.1 summarizes KSC's main facility energy sources and their costs. Tables 14-2 and 14-3 summarize the electric and natural gas utility structures at KSC, respectively.

Table 14-1. FY 2002 Energy Summary.

Source	Consumption	MBtu	%	$M
Electricity	293,653 MWh	1,001,9440	72.4	14.57
Natural Gas	363,478 Dth	363,478	26.2	1.85
#2 Fuel Oil	115,420 gal	16,009	1.2	0.12
Propane	35,751 gal	3,414	0.2	0.03
	TOTAL	**1,384,845**		**16.57**

Includes about $1.1M reimbursable tenants (Visitor Complex, Air Force, etc.)

Table 14-2. KSC Electric Distribution Summary.

Source	Electricity
% of KSC Energy	73%
Contracts	Air Force 45th Space Wing (45SW) contracts with Florida Power & Light (FPL).
Metering/Billing	FPL meters/bills KSC directly for 10 accounts: Two major 115 KiloVolt substations on FPL's Commercial/Industrial Load Control rate (LC-39 Area and Industrial Area), and eight small accounts for remote loads. FPL meters/bills 45SW for CCAFS substations and NASA reimburses 45SW for NASA facilities and the CCAFS Industrial Area.
Ownership	KSC owns/maintains 13.2 and 13.8 KV distribution systems.
Submetering	KSC has about 240 submeters for energy/cost management. These meters cover 82% of consumption, but not at the facility level; the remaining usage is calculated by subtracting metered values from totals or estimating. KSC is pursuing networking meters for more automated input into an information management system.
Central Plants	Both the Industrial Area and LC-39 Area have a central utility plant that produces air conditioning chilled water and distributes to various buildings. KSC is pursuing metering plant production and facility usage.
Backup	Diesel generation and uninterruptible power supply units backup critical loads. Portions of the generation capability participate in FPL's load control program and qualify the substations for a cheaper rate.

Table 14-3. KSC Natural Gas Distribution Gas.

Source	Natural Gas
% of KSC Energy	26%
Contracts	NASA contracts with NUI/City Gas for local delivery service, and utilizes a Defense Energy Support Center (DESC) contractor for gas commodity.
Metering/billing	City Gas meters/bills NASA directly for local delivery to 32 accounts at KSC and CCAFS: Four large boiler plants and 28 smaller loads. The DESC contractor bills NASA for the commodity and its transportation across the interstate pipeline into City Gas's local system.
Ownership	City Gas owns the distribution pipes/meters.
Submetering	No KSC submetering, because City Gas meters each load.
Central Plants	Industrial Area, Hypergol Maintenance Facility Area, LC-39 Area, and the Assembly & Refurbishment Facility Complex each have a central utility plant that produces heating/reheating high temperature hot water and distributes to various buildings. KSC is pursuing metering plant production and facility usage.
Backup	KSC's three largest boiler plants have fuel oil back up and qualify for City Gas's cheaper interruptible rates.

Spaceport Services Supply, Equipment, Transportation, & Center Support Branch coordinates KSC's response to transportation mandates with General Services Administration. Tables above do not include about 140MBtu and $1.4M of vehicles and other equipment energy.

14.4 INITIATIVES

EWG updated KSC's Energy Management Five-Year Plan, obtained Center Director's approval, and submitted to NASA Headquarters in August 2001. The plan divides energy goals among the major programs at KSC. The sections identify each program and how it will meet its share of the goals. KSC tracks progress towards energy efficiency goals using separate 10-box metrics for Standard Facilities and Energy Intensive Facilities. Previous initiatives include lighting retrofits, heating, ventilation and air conditioning (HVAC) control conversions from pneumatic to digital, conversion to variable speed motors drives, and minimal renewable energy technology applications as warranted by life-cycle cost effectiveness (see Figure 14-1). Project funding sources include NASA Construction of Facilities (CofF) appropriations, facilities O&M contracts (performance requirements), self-funding projects (repay third-party loan with savings), DOE grants, and utility rebates from previous energy projects.

Please see http://environmental.ksc.nasa.gov/ for additional information.

Warning Signs and Alarms

Gate Operation

Lighting

Security Systems

Figure 14-1. Examples of KSC Renewable Energy Applications

SECTION XV

RECYCLING AND AFFIRMATIVE PROCUREMENT AND POLLUTION PREVENTION

15.1 RECYCLING AND AFFIRMATIVE PROCUREMENT

15.1.1 REGULATORY OVERVIEW

Section 6002 of the Resources Conversation and Recovery Act (RCRA) and Executive Order (EO) 13101: *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition* direct Federal agencies to purchase recycled content products, whenever possible. In response to the RCRA and EO, the U.S. Environmental Protection Agency (EPA) developed Comprehensive Procurement Guidelines (CPG) for Federal agencies procuring recyclable products within their Affirmative Procurement Programs. Seven product categories were established: 1) paper and paper products, 2) vehicular products, 3) construction products, 4) landscaping products, 5) transportation products, 6) park and recreation products, and 7) non-paper products.

The Affirmative Procurement and Recycling Programs must comply with the RCRA, the Federal Acquisition Regulations (FAR 23.4), EO 13101, and the NASA's Procedures and Guidelines (NPG 8830.1). The regulations require NASA to purchase items containing post-consumer recycled materials, environmentally preferable products, recycling, and bio based products.

EO 13101 requires that KSC track purchases of designated EPA items and submit a yearly report each March. The NASA Environmental Tracking System (NETS) was created to track the data. NETS is an automated tracking system used for reporting recycled content product purchases made by NASA as well as prime contract purchasing. NETS enables precise record-tracking and reporting using standardized formats.

15.1.2 NASA AGENCY RECYCLING AND AFFIRMATIVE PROCUREMENT

The overall Agency goal to increase waste prevention, recycling, and use of recycled content and environmentally preferable products and services shall encompass:

- Improving and expanding the diversion of solid waste from landfills and incinerators through waste prevention, reuse, and recycling.
- Facilitating the development and expansion of markets for recycled content and environmentally preferable products through acquisition of products and services, research and development programs, assistance programs, and other appropriate programs.
- Facilitating the development and expansion of technology for waste prevention, recycling (including design for disassembly), and manufacture of recycled content and environmentally preferable products.
- Expanding waste prevention and recycling in the daily operation of NASA, and

- Implementing cost-effective procurement programs favoring the purchase of environmentally preferable products and services.

15.1.3 KSC RECYCLING AND AFFIRMATIVE GOALS

Our goal at the Kennedy Space Center is to maximize the amount of materials recycled while reducing the amount of recyclable material going to our on-site landfill and Brevard County landfill. NASA's current goal is to increase recycling activities by 35 percent using FY93 data as a baseline. KSC is committed to initiating, expanding, and improving the recycling program to capture and collect all recyclable material. KSC is encouraging all to maximize the procurement of CPG items. Appendix D provides data for the CY 2001 KSC CPG Items Purchasing and Recycling Items and Methods for Recycling Paper and Cardboard, respectively.

15.1.4 KSC RECYCLING REVENUES

Recycle funds are generated at the Reutilization, Recycling, and Marketing Facility (RRMF) through the Government Surplus Sales Program. KSC has a sales contract for the purchase and recycling of scrap metal. The contract covers items such as pipe, pumps, valves, generators, compressors, air conditioners, furniture, hardware, motors, blocks, tackle, rope fittings, hydraulic lifts, drums, appliances, hand tools, scaffolding, platforms, scrap steel, etc. The value of this property is in its material content only. The contractor pays 37.35 percent of the Birmingham market for the number of pounds of scrap that is removed each month. The NASA KSC Property Disposal Office reviews the contractor's weight tickets and provides a monthly invoice for the amount due the Government. The contract covers one year with four 1-year extensions. With a 5-year extended contract, the contractor purchased a bailer to maximize time and profit margin. The contractor is operating under the third year of the contract and the operation is going well.

Scrap aluminum, stainless steel, copper wire and cable accumulations are collected for three to four months. They are normally sold by the pound, which brings in the maximum amount of recycling funds. However, due to plans being worked to move the RRMF West Yard, each accumulation is sold as a lot. This enhances the cleanup of the West Yard. The lots are sold by sealed bid or auction.

Electronics and computer equipment are sold by auction when they are received in scrap condition and have no value other than their metal content. They are sold in large lots to the highest bidder.

When habitable trailers are sold they are considered recycled since they are reutilized. Trailers that are damaged or do not meet Florida State specifications for public use are demolished at the RRMF and any metal content is recycled.

15.2 POLLUTION PREVENTION

15.2.1 REGULATORY OVERVIEW

The KSC Pollution Prevention (P2) Program is about source reduction, waste minimization, recycle, and reuse. It is about the maximum feasible use of materials and energy and the reduction of all wastes generated at KSC.

KSC P2 involves the comprehensive assessment of the Center's purchasing decisions, operations, maintenance, waste management and disposal methods. KSC P2 includes the developing and implementing practices that reduce the purchase and use of hazardous and non-hazardous materials, the use of energy, water, and other resources, and the generation of and/or treatment and disposal wastes.

The components of KSC P2 Program include: a) Pollution Prevention Opportunities; b) Pollution Prevention Activities; c) Pollution Prevention Partnering; d) Emergency Planning and Community Right-to-Know (EPCRA) Material Safety Data Sheet; e) EPCRA Toxic Releases Inventory; f) EPCRA Tier II Data; g) Affirmative Procurement Program; h) Recycling Program; i) Alternative Fueled Vehicles; j) Ozone Depleting Substances; k) Environmental Justice Plan; and l) Stormwater Pollution Prevention Plan.

In response to EO 13148, *Greening the Government through Leadership in Environmental Management,* dated April 21, 2000, the NASA Guidance to Implement EO 13148, and the NASA Procedures and Guidelines, NPG 8820.3, *Pollution Prevention*, the KSC Environmental Program Branch (EPB) has established goals for KSC P2 Program.

15.2.2 KSC POLLUTION PREVENTION (P2) GOALS

- Develop and implement Environmental Management Systems by December 31, 2005.
- Establish and implement audit programs for environmental compliance.
- Revise and update annually the KSC Pollution Prevention Implementation Plan.
- Report the annual Center activities under EPCRA.
- Reduce the reportable KSC Toxic Release Inventory (TRI) releases and off-site transfers of toxic chemicals for treatment and disposal by 10 percent annually, or by 40 percent overall, by December 31, 2006.
- Reduce the use or waste of priority or selected chemicals by 50 percent by December 31, 2006.
- Develop a plan to phase out the procurement of Class I Ozone Depleting Substances by December 31, 2010.
- Implement environmentally sound landscape practices.
- Comply with EO 13148 requirements and note EO 13148 recommendations.

Appendix D provides a detail list of KSC P2 goals.

15.2.3 KSC EPCRA IMPLEMENTATION PLAN

EPCRA intends to improve local community access for information about chemical hazards and state and local emergency response capabilities. EPCRA has three main objectives:

- To bolster local emergency planning efforts
- To improve emergency notification in the event of a release of hazardous chemicals
- To develop a baseline on routine chemical releases into the environment

To meet these objectives, EPCRA created four types of reporting obligations for facilities that store or manage specified listed chemicals. All information submitted pursuant to EPCRA regulations is publicly accessible, unless protected by a trade secret claim.

15.2.3.1 Notification of Extremely Hazardous Substances. EPCRA §302 requires facilities to notify the State Emergency Response Commission (SERC) and the Local Emergency Planning Committee (LEPC) of the presence of any "extremely hazardous substance" if it has the substance in excess of the specified "threshold planning quantity." The list of such substances is in 40 CFR Part 355, Appendix D. It also directs the facility to appoint an emergency response coordinator. Through the KSC Implementation Plan, EPB will notify the SERC and the LEPC on all extremely hazardous substances at KSC.

15.2.3.2 Notification During Releases. EPCRA §304 requires facilities to notify the SERC and the LEPC in the event of a release exceeding the "reportable quantity" of a Comprehensive Environmental Resources Compensation and Liability Act (CERCLA) hazardous substance or an EPCRA extremely hazardous substance. EPCRA extremely hazardous substances and reportable quantities are listed in 40 CFR 355. Through the KSC Implementation Plan, EPB tracks all "reportable quantity" releases and any other "non-reportable quantity" releases, annually, by using the Pollution Incident Report (PIR). Appendix D provides the KSC PIR Process System and the latest CY 2002 KSC PIR data, respectively.

15.2.3.3 Emergency Planning (EPCRA Tier II). EPCRA §311 and §312 require facilities to notify SERC, LEPC, and the KSC Fire Department of all hazardous chemicals stored at KSC. Occupational Health and Safety Administration also requires KSC to have on file Material Safety Data Sheets (MSDS). This information helps the local Government respond in the event of a spill or release of the chemical. These requirements are found at 40 CFR 370, Hazardous Chemical Reporting: Community Right-to-Know. Through the KSC Implementation Plan, on March 1st of each year, EPB will submit the EPCRA Tier II Report to EPA, SERC, LEPC and the KSC Fire Department. Tables 15-1 and 15-2 list reportable extremely hazardous substances (EHS) and reportable non-EHS, respectively. Appendix D identifies the KSC EPCRA Tier II Reporting Process and KSC ECPRA Tier II Data, respectively.

15.2.3.4 Toxic Release Inventory (Form R). EPCRA §313 of Title III requires manufacturing facilities in SIC Codes 20 through 39, who have 10 or more employees and manufacture, process, or use specified chemicals in amounts greater than threshold quantities, to submit an annual toxic chemical release report to EPA. This program is called the Toxic Release Inventory (TRI). The report, commonly known as Form R, 1) covers releases and transfers of toxic chemicals to various facilities and environmental media, 2) allows EPA to compile the national TRI database, and 3) assists in research and development of regulations, guidelines, and standards. The TRI data are used nationally to track pollution prevention progress by industry. These requirements can be found at 40 CFR 372, Toxic Chemical Release Reporting: Community Right-to-Know. Through the KSC Implementation Plan, on July 1st of each year,

Table 15-1. Reportable Extremely Hazardous Substances (EHS).

EHS		RY 1998		RY 1999		RY 2000		RY 2001	
CHEMICAL DESCRIPTION	CAS NUMBER	Max Daily Amt (lbs)	Avg Daily Amt (lbs)	Max Daily Amt (lbs)	Avg Daily Amt (lbs)	Max Daily Amt (lbs)	Avg Daily Amt (lbs)	Max Daily Amt (lbs)	Avg Daily Amt (lbs)
1,1-dimethyl Hydrazine	57-14-7	36,953	13,198	18,765	18,765	18,765	18,765	18,765	18,765
Methyl Hydrazine	60-34-4	139,766	76,807	150,279	105,819	150,279	105,819	147,969	103,293
Epichlorohydrin (SRM)	106-89-8	263,980	199,096	263,980	199,096	263,980	199,096	263,980	199,922
Hydrazine	302-01-2	35,722	2,324	40,715	38,029	40,714	38,028	40,715	38,029
Diglycidyl Ether(dge)	7/5/2238	N/R	N/R	1,013	507	508	407	N/R	N/R
Ammonia	7664-41-7	4,376	2,721	4,506	2,311	6,486	3,631	6,716	4,110
Sulfuric acid	7664-93-9	3,887	3,024	4,189	3,695	3,814	2,251	4,256	2,825
Nitric Acid	7697-37-2	6,211	4,399	7,020	4,509	7,845	6,187	7,981	6,101
Chlorine	7782-50-5	3,300	3,000	3,300	3,000	2,550	2,400	2,400	2,100
Nitrogen Dioxide	10102-44-0	211,991	180,055	327,341	253,833	327,341	253,833	324,031	249,963

Table 15-2. Reportable Non-Extremely Hazardous Substances.

Non-EHS		RY 1998		RY 1999		RY 2000		RY 2001	
CHEMICAL DESCRIPTION	CAS NUMBER	Max Daily Amt (lbs)	Avg Daily Amt (lbs)	Max Daily Amt (lbs)	Avg Daily Amt (lbs)	Max Daily Amt (lbs)	Avg Daily Amt (lbs)	Max Daily Amt (lbs)	Avg Daily Amt (lbs)
Isopropyl Alcohol	67-63-0	30,430	21,987	20,403	13,003	53,596	8,905	34,818	9,593
Acetylene	74-86-2	58,575	52,567	174,927	174,927	174,926	174,926	174,927	174,927
Propane	74-98-6	52,293	41,287	49,439	40,271	40,411	29,586	39,107	29,281
Freon 21	75-43-4	25,136	24,343	22,000	22,000	N/R	N/R	24,018	24,018
Freon 22	75-45-6	N/R	N/R	N/R	N/R	N/R	N/R	18,327	11,602
Halon 1301	75-63-8	15,600	14,300	20,000	20,000	20,000	20,000	24,027	24,027
Freon 12	75-71-8	N/R	N/R	N/R	N/R	31,269	30,822	N/R	N/R
Freon 113	76-13-1	201,050	109,352	366,287	348,250	355,020	339,983	353,941	309,612
CFC-114	76-14-2	20,440	12,320	N/R	N/R	N/R	N/R	N/R	N/R
Citric Acid	77-92-9	N/R	N/R	62,368	55,360	84,580	77,572	81,680	75,672
Methylenebis - MDI	101-68-8	N/R	N/R	11,100	5,046	N/R	N/R	N/R	N/R
Malathion	121-75-5	N/R	N/R	375,675	187,838	N/R	N/R	N/R	N/R
Perchloroethylene	127-18-4	N/R	N/R	13,306	6,859	12,589	6,594	12,590	6,595
Bromacil	314-40-9	N/R	N/R	12,800	6,400	N/R	N/R	N/R	N/R
Diuron	330-54-1	N/R	N/R	19,200	9,600	N/R	N/R	N/R	N/R
Carbon Monoxide	630-08-0	N/R	N/R	N/R	N/R	10,137	10,137	N/R	N/R
Iron oxide (SRM)	1309-37-1	46,585	35,135	46,585	35,135	46,585	35,134	46,585	35,280
Potassium Hydroxide	1310-58-3	N/R	N/R	N/R	N/R	10,047	4,588	N/R	N/R
Sodium Hydroxide	1310-73-2	102,879	85,548	148,385	141,369	166,614	153,598	77,840	65,801
Xylene	1330-20-7	N/R	N/R	13,638	8,592	N/R	N/R	N/R	N/R
Hydrogen	1333-74-0	1,098,626	613,584	1,773,415	1,209,774	1,773,414	1,209,774	2,067,967	1,335,090
Dimethylamine Salt	2008-39-1	N/R	N/R	65,023	32,511	N/R	N/R	N/R	N/R
HCFC-124	2837-89-0	N/R	N/R	N/R	N/R	10,000	10,000	16,000	16,000
Potassium Chlorate	3811-04-9	N/R	N/R	N/R	N/R	209,760	209,760	207,360	207,360
2,4-D, isopropylamine salt	5742-17-6	N/R	N/R	17,812	8,906	N/R	N/R	N/R	N/R
Aluminum Powder	7429-90-5	2,173,952	1,639,611	2,173,952	1,639,611	2,174,128	1,639,696	2,173,952	1,646,417

Non-EHS		RY 1998		RY 1999		RY 2000		RY 2001	
CHEMICAL DESCRIPTION	**CAS NUMBER**	**Max Daily Amt (lbs)**	**Avg Daily Amt (lbs)**	**Max Daily Amt (lbs)**	**Avg Daily Amt (lbs)**	**Max Daily Amt (lbs)**	**Avg Daily Amt (lbs)**	**Max Daily Amt (lbs)**	**Avg Daily Amt (lbs)**
(SRM)									
Argon	7440-37-1	N/R	N/R	12,096	11,336	15,670	13,008	14,471	12,283
Helium	7440-59-7	105,875	100,533	797,583	698,337	797,541	698,295	918,420	710,753
Zinc	7440-66-6	18,866	9,558	22,054	15,682	14,257	9,796	15,146	12,166
Sodium Chloride	7647-14-5	N/R	N/R	N/R	N/R	104,800	104,800	N/R	N/R
Sulfur	7704-34-9	N/R	N/R	17,738	17,738	17,738	17,738	N/R	N/R

Non-EHS (continued)		RY 1998		RY 1999		RY 2000		RY 2001	
CHEMICAL DESCRIPTION	**CAS NUMBER**	**Max Daily Amt (lbs)**	**Avg Daily Amt (lbs)**	**Max Daily Amt (lbs)**	**Avg Daily Amt (lbs)**	**Max Daily Amt (lbs)**	**Avg Daily Amt (lbs)**	**Max Daily Amt (lbs)**	**Avg Daily Amt (lbs)**
Hydrogen Peroxide	7722-84-1	N/R	N/R	N/R	N/R	31,560	29,037	29,402	26,880
Nitrogen	7727-37-9	859,054	652,793	9,179,942	8,086,438	9,213,331	8,118,741	9,550,456	7,375,041
Oxygen	7782-44-7	16,113,367	9,709,704	22,291,676	14,211,696	22,292,925	14,212,946	25,232,042	14,901,419
Ammonium Perchlorate (SRM)	7790-98-9	9,627,500	7,261,132	9,627,500	7,261,132	9,627,500	7,621,132	9,627,500	7,291,277
Petroleum oil (Lubricating oils)	8002-05-9	82,875	49,295	110,451	96,841	87,013	68,837	90,213	62,976
Gasoline	8006-61-9	56,393	54,107	N/R	N/R	N/R	N/R	N/R	N/R
Kerosene	8008-20-6	379,386	358,387	661,073	660,389	659,963	659,916	N/R	N/R
Glyphosate, isopropylamine salt	38641-94-0	N/R	N/R	231,568	115,784	42,937	30,239	N/R	N/R
Petroleum light distillates	64742-47-8	189,962	51,186	310,587	301,719	309,778	298,870	16,041	4,618
Petroleum mid distillates	68476-34-5	1,179,827	683,503	694,504	655,318	786,787	735,697	846,876	822,201
Petroleum Distillates	68476-34-6	N/R	N/R	64,362	63,063	17,765	16,318	N/R	N/R
Diesel (fuel oil #2)	77650-28-3	123,375	98,700	N/R	N/R	N/R	N/R	N/R	N/R
Imazapyr	81334-34-1	N/R	N/R	25,010	12,505	N/R	N/R	N/R	N/R

EPB will submit the TRI Report to EPA and SERC. Appendix D identifies the KSC TRI Reporting Process and KSC TRI Data, respectively.

15.3 KSC ALTERNATIVE FUELED VEHICLES

EO 13149: *Greening the Government through Federal Fleet and Transportation Efficiency* requires Federal agencies to reduce its entire vehicle fleet's annual petroleum consumption by at least 20 percent by the end of FY 2005, compared with FY 1999 petroleum consumption levels. The EO also requires Federal agencies to use the alternative fuels to meet the majority of the fuel requirements of those motor vehicles by the end of FY 2005. Appendix D provides data for KSC Alternative Fueled Vehicle (AFV) Natural Gas Usage.

15.4 KSC OZONE-DEPLETING SUBSTANCES

EO 12843: *Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances* (ODS) directs Federal agencies to minimize the procurement of products containing ODS. The EO also requires Federal agencies to implement policies that will reduce emissions of ODS, promote recycling of ODS, and cease the procurement of nonessential products containing or manufactured with ODS.

15.5 KSC PROCUREMENT OF ENERGY EFFICIENT COMPUTERS

EO 12845 directs NASA to ensure that all computer equipment purchased meets EPA "*Energy Star*" requirements for energy efficiency. Case-by-case exemptions are allowed, taking into account commercial availability, significant cost differentials, NASA's mission, and NASA's performance requirements. NASA is also directed to educate its computer users concerning the economic and environmental benefits derived from using this energy efficient, low-power standby feature. The KSC Information Technology Group and the KSC Procurement Office are currently purchasing the EPA "*Energy Star*" computer equipment.

APPENDIX A

AREAS AND DESCRIPTIONS OF SOIL SERIES ON KSC

Descriptions of the Soil Series and Land Types on KSC (modified from Schmalzer and Hinkle 1990b).

Anclote sand is a nearly level, very poorly drained, sandy soil in marshy depressions in flatwoods, broad areas on floodplains, and in poorly defined drainageways. In most years the water table is < 10 in (25 cm) for > 6 months and seldom > 40 in (102 cm). These soils are occasionally flooded for 2-7 days after heavy rain (Huckle et al. 1974). On KSC, Anclote soils are primarily in swales of flatwoods and scrub and along drainage ways.

Arents are nearly level soils made up of heterogeneous material removed form other soils and used in land leveling, as fill material or as the final cover of a sanitary landfill (Baldwin et al. 1980).

Astatula fine sand is a nearly level to gently sloping, excessively drained, sandy soil on high, undulating ridges. It has low organic matter content and low natural fertility. The water table is typically below 120 in (305 cm). This series is better drained than Pomello and lacks the A2 and B horizons of Paola (Huckle et al. 1974). On KSC, this series is found primarily on the higher ridges north of Haulover Canal. The Astatula-Urban land complex map unit is made up of nearly level to sloping Astatula soils that have been used for urban development (Baldwin et al. 1980). The soil coverage from the St. Johns River Water Management District considers these Candler series (Table A-1).

Basinger sand is a nearly level, poorly drained, sandy soil in sloughs of poorly defined drainageways and depressions in flatwoods. In most years, the water table is < 10" (25 cm) for 2-6 months, between 10-40 in (25-102 cm) for 6 months, and > 40 in (102 cm) for short periods in the dry season. This series is better drained than Anclote and lacks the weakly cemented Bh horizon of Immokalee (Huckle et al. 1974). On KSC, Basinger sand occurs primarily in swales in flatwoods and scrub.

Beaches are the narrow sandy strips along the Atlantic coast composed of fine to coarse sand mixed with multicolored shells and shell fragments. Seawater regularly over washes the larger part of these areas at high tide but the higher areas only at equinoctal or storm-driven tides (Huckle et al. 1974).

Bradenton fine sand, shallow variant is a nearly level, poorly drained soil with limestone at a depth of ca. 40 in (102 cm). The water table is < 10 in (25 cm) for 2-6 months, between 10-30 in (25-76 cm) for > 6 months, and > 30 in (76 cm) for short periods in the dry season. These soils may be flooded for 2-7 days once in 1-5 years. This series is better drained than Copeland (Huckle et al. 1974). On KSC, this series occurs mainly in the central and western parts of Merritt Island near areas mapped as the Copeland complex.

Bulow sand is a gently sloping, well drained, moderately deep, sandy soil underlain by differentially weathered coquina on narrow sand ridges. The water table is typically below 72 in (183 cm) (Baldwin et al. 1980). Bulow sand occurs only to a minor extent on KSC (Table A-1) and is found on ridges north of Haulover Canal.

Canaveral sand is a nearly level and gently undulating, moderately well drained, sandy soil mixed with shell fragments. The map unit consists of 60 percent Canaveral sand and 30 percent more poorly drained Canaveral sand in sloughs between ridges with a thicker, darker surface layer and the water table closer to the surface for longer periods. Canaveral sand is not as well drained as Palm Beach but better drained than Anclote (Huckle et al. 1974). On KSC, Canaveral sand is found primarily on the coastal strip inland from Palm Beach sand. It is of modest extent on KSC (Table A-1) but occupies most of Cape Canaveral. The Canaveral-Urban land complex consist of about 20-40 percent urban development; the remaining areas are a mixture of sand and shell dredged from the Indian and Banana Rivers, deposited on tidal marshes and swamps, and then leveled and smoothed (Huckle et al. 1974).

Canova peat is a nearly level, very poorly drained soil with a peat surface layer and loamy subsoil occurring on broad floodplains. The water table is < 10 in (25 cm) for 9-12 months, continuously flooded for 3-6 months, and > 10 in (25 cm) for short periods in the dry season. This series is more poorly drained than Felda and Winder soils and has an organic surface layer (Huckle et al. 1974). Canova peat is of minor extent on KSC (Table A-1).

Cassia fine sand is a nearly level, somewhat poorly drained but moderately permeable soil that occurs on low sandy swells slightly higher than the adjacent flatwoods. The water table is between 15-40 in (38-102 cm) during rainy seasons. This series is less well drained than Orsino but better drained than Myakka soils (Baldwin et al. 1980).

Chobee fine sandy loam is a nearly level, very poorly drained, loamy soil with a thick black surface layer that occurs in marshy depressions and floodplains. The water table is < 10 in (25 cm) for 6-9 months, between 10-40 in (25-102 cm) for 3-6 months, > 40 in (102 cm) for short periods in the dry season, and may be flooded continuously for 1-6 months. This series is more poorly drained than Felda (Huckle et al. 1974). On KSC, a minor acreage (Table A-1) of this series occurs on the central and western part of Merritt Island.

Cocoa sand is a nearly level and gently sloping, well-drained, sandy soil over coquina. The water table is > 72 in (183 cm) all year (Huckle et al. 1974). On KSC, this series occurs primarily on low ridges north and south of Haulover Canal.

Copeland is a nearly level, sandy to loamy, very poorly drained soil on low flats underlain by limestone. The Copeland complex map unit consists of several nearly level, very poorly drained soils where the water table is < 10 in (25 cm) for > 6 months, between 10-30 in (25-76 cm) in the dry season, and flooded 7-30 days once in 5-20 years. Soils in the complex differ in depth to the limestone layer (Huckle et al. 1974). On KSC, this complex occurs mainly in the central and western part of Merritt Island west of State Route 3.

Daytona sand is a moderately well drained, nearly level to gently sloping soil on undulating sandhills or slightly elevated places in the flatwoods. The water table is between 40-50 in (102-127 cm) for 1-4 months per year in the wet season and > 72 in (183 cm) in the dry season (Baldwin et al. 1980). On KSC, small areas of this series (Table A-1) are mapped on ridges north of Haulover Canal in Volusia County.

Felda sand is a nearly level, poorly drained soil on broad low flats, in sloughs, depressions, and poorly defined drainageways. The water table is < 10 in (25 cm) for 2-6 months and between 10-40 in (25-102 cm) for the rest of the year. Water may be above the surface for 2-7 days in 1-3 months per year. Depressions are flooded for > 6 months per year (Huckle et al. 1974). The soil coverage from the St. Johns River Water Management District combines Felda soils into the Riviera series (Table A-1).

Felda and Winder soils consist of poorly drained soils in low sloughs and slightly higher hammocks. The map unit consists of about 65 percent sloughs and 35 percent hammocks. In the sloughs, the soils are 35 percent Felda, 30 percent Winder, and < 20 percent Chobee, Floridana, and/or Wabasso. In the hammocks, the soils are 55 percent a soil similar to Wabasso, but over limestone and the remainder a soil similar to Copeland (Huckle et al. 1974). These soils occur in low areas in flatwoods on the east side of Merritt Island and on low flats on the west side of the island. The soil coverage from the St. Johns River Water Management District combines Felda soils into the Riviera series (Table A-1).

Felda and Winder soils, ponded are the landward areas of former high tidal marsh impounded for mosquito control and now continuously flooded for > 6 months per year. About 50 percent of the soils are Felda and 25 percent Winder (Huckle et al. 1974). These soils are also mapped in some of the large interior wetlands on KSC. The soil coverage from the St. Johns River Water Management District combines Felda soils into the Riviera series (Table A-1).

Floridana sand is a nearly level, very poorly drained soil in broad areas of floodplains and small to large marshy depressions. The water table is < 10 in (25 cm) for 6-9 months and between 10-30 in (25-76 cm) for the rest of the year. This series is more poorly drained than Felda or Winder (Huckle et al. 1974). Only minor areas of this soil occur on KSC (Table A-1).

Holopaw sand is a nearly level, poorly drained soil of broad low flats and depressions (Baldwin et al. 1980).

Hydraquents are variable, silty, clayey, or loamy tidal deposits in mangrove swamps and islands. The outer edges experience tidal overwash daily, while the inner parts are slightly elevated and are inundated only during storms and equinoctial tides. Hydraquents are mapped in Volusia County (Baldwin et al. 1980); in Brevard County, the map unit of Tidal swamp is apparently equivalent (Huckle et al. 1974).

Immokalee sand is a nearly level, poorly drained, sandy soil in broad areas in flatwoods, low ridges between sloughs, and in narrow areas between sand ridges and lakes or ponds. The water table is <10 in (25 cm) for 1-2 months, between 10-40 in (25-102 cm) for > 6 months, and > 40 in (102 cm) for short dry periods. It may be flooded for 2-7 days once in 1-5 years (Huckle et al. 1974). Immokalee is one of the major soil series in flatwoods and scrub on KSC (Table A-1).

Malabar sand is a nearly level, poorly drained soil in broad low areas, sloughs, and poorly defined drainageways (Huckle et al. 1974). It is of minor extent on KSC (Table A-1).

Montverde peat is a nearly level, very poorly drained, thick organic soil in depressions, marshes, and swamps (Huckle et al. 1974). It is of minor extent on KSC (Table A-1).

Myakka sand is a nearly level, poorly drained, sandy soil in broad areas in flatwoods, low ridges between sloughs, and in narrow areas between sand ridges and lakes or ponds. The water table is < 10 in (25 cm) for 1-4 months, between 10-40 in (25-102 cm) for > 6 months, and > 40 in (102 cm) for short dry periods. It may be flooded for 2-7 days once in 1-5 years (Huckle et al. 1974). Myakka is an important series in flatwoods and wetter scrub on KSC (Table A-1) where it is in lower areas than Immokalee. Myakka-Urban land complex consists of Myakka soil, Myakka soil that has been altered for use as building sites, and urban development (Huckle et al. 1974).

Myakka sand, ponded is a nearly level, poorly drained, sandy soil in shallow depressions in flatwoods. It is similar to Myakka but is flooded for 6-12 months per year (Huckle et al. 1974). Only minor areas of this series occur on KSC (Table A-1).

Myakka variant fine sand is a nearly level, poorly drained, sandy soil in swells in flatwoods and in slightly higher areas in hardwood hammocks near the coast. The water table is < 10 in (25 cm) in the rainy season. This series differs form Myakka in the fine sand texture and the presence of a neutral to alkaline IIC horizon with shell fragments (Baldwin et al. 1980). Small areas of this series (Table A-1) occur in the northern section of KSC in Volusia County.

Orsino fine sand is a nearly level, moderately well drained, sandy soil on moderately low ridges and between high ridges and poorly drained areas. The water table is between 40-60 in (102-152 cm) for > 6 months, during dry periods it is > 60 in (152 cm), and during wet periods between 20-40 in (51-102 cm) for 7 days to 1 month (Huckle et al. 1974). Small areas of this soil (Table A-1) occur on ridges in the central part of Merritt Island.

Palm Beach sand is a nearly level and gently sloping, excessively drained soil on dune-like ridges that roughly parallel the Atlantic Ocean and consists of mixed sand and shell fragments. The water table is > 120 in (305 cm). This series is better drained than Canaveral sand (Huckle et al. 1974). On KSC, it occurs on the recent dunes inland from the beaches.

Paola fine sand is a nearly level to strongly sloping, excessively drained, sandy soil of the tops and sides of ridges. This series is better drained than Orsino and much better drained than Immokalee or Myakka (Huckle et al. 1974). On KSC, this series occurs on the higher ridges in the center of Merritt Island and on ridges north of Haulover Canal.

Parkwood fine sand is a nearly level, poorly drained soil with loamy subsoil occurring in hammocks along streams, poorly defined drainageways, and depressions. The water table is < 10 in (25 cm) for 2-4 months per year in wet periods, and between 10-30 in (25-76 cm) the rest of the year. The soil may be flooded for 7 days to 1 month once in 1-5 years (Huckle et al. 1974). Small areas of this series (Table A-1) occur on KSC, generally near the Copeland complex. The soil coverage from the St. Johns River Water Management District considers these Hilolo series soils (Table A-1).

Pineda fine sand is a nearly level, poorly drained, sandy soil in broad low flats in the flatwoods, in poorly defined drainageways, and at the edges of sand ponds and swamps. The water table is < 10 in (25 cm) for 1-6 months; some areas have standing water for 7 days to 6 months in some years (Huckle et al. 1974).

Pineda sand, dark surface variant is a nearly level, poorly drained, sandy soil in broad hammock and low sloughs. The water table is within 10 in (25 cm) for 1-2 months most years. The soil is flooded for 2-7 days every 1-5 years (Huckle et al. 1974). The soil coverage from the St. Johns River Water Management District considers these Delray sand-commonly flooded (Table A-1).

Pits are excavations from which soil and geologic material have been removed for use in road construction or development (Baldwin et al. 1980).

Placid fine sand, depressional is a very poorly drained, nearly level soil in wet depressions. The water table is above the surface for > 6 months per year. This series is lower and more poorly drained than Myakka or St. Johns (Baldwin et al. 1980). Minor areas of this series occur on KSC (Table A-1).

Pomello sand is a nearly level, moderately well drained, sandy soil on broad low ridges and low knolls in the flatwoods. The water table is between 30-40 in (76-102 cm) for 2-4 months per year and between 40-60 in (102-152 cm) for > 6 months per year. This series is better drained than Immokalee or Myakka but more poorly drained than St. Lucie (Huckle et al. 1974). On KSC, Pomello sand is primarily on the broader ridges of central Merritt Island.

The Pomona-St. Johns complex consists of nearly level, poorly drained Pomona and St. Johns soils that are covered with standing water for long periods. These soils occur in drainageways and broad depressions in flatwoods (Baldwin et al. 1980).

Pompano is a nearly level, poorly drained, sandy soil on broad flats, in shallow depressions, and in sloughs. The water table is < 10 in (25 cm) for 2-6 months per year, between 10-40 in (25-102 cm) for > 6 months per year, and > 40 in (102 cm) in the dry season (Huckle et al. 1974).

The Pompano-Placid complex map unit consists of nearly level, poorly drained Pompano soils and very poorly drained Placid soils in depressions in flatwoods. The soils are too intermingled on the landscape to map separately at the scale of the soil survey (Baldwin et al. 1980).

Quartipsamments are nearly level to steeply sloping soils reworked by earthmoving equipment. The soil material is derived from a variety of sandy soils (Huckle et al. 1974).

Riviera fine sand is a poorly drained, nearly level soil in broad low flats. The water table is < 10 in (25 cm) for 2-6 months per year and > 40 in (102 cm) for ca. 6 months per year (Baldwin et al.

1980). Minor areas of this series were mapped in the northern part of Merritt Island in Volusia County. The soil coverage from the St. Johns River Water Management District combines Felda soils into the Riviera series (Table A-1).

St. Johns sand is a nearly level, poorly drained, sandy soil on broad low ridges in the flatwoods. The water table is < 10 in (25 cm) for 2-6 months per year and between 10-40 in (25-102 cm) the rest of the time. During extended dry periods it may be > 40 in (102 cm), and the soils may be flooded for 2-7 days following heavy rain (Huckle et al. 1974). This series occurs in low swales in the flatwoods and scrub on the eastern part of Merritt Island and in low flats on the western part of the island.

St. Johns soils, ponded are in sloughs, poorly defined drainageways, and shallow intermittent ponds in the flatwoods. The water table is < 10 in (25 cm) for 6-12 months per year, and they may be flooded for > 6 months per year (Huckle et al. 1974). On KSC, this series is primarily in swales in flatwoods and scrub.

St. Lucie fine sand is a deep, nearly level to strongly sloping, excessively drained, sandy soil on high dune-like ridges and isolated knolls. The water table is > 120 in (305 cm) (Huckle et al. 1974). Only minor areas of this soil occur on KSC (Table A-1).

Satellite sand is a somewhat poorly drained but rapidly permeable soil found on low and moderately high sandy hills in flatwoods. It is better drained than the associated Immokalee and Myakka soils but not as well drained as Daytona soils (Baldwin et al. 1980).

Smyrna fine sand is a nearly level, poorly drained, moderately permeable soil of broad, nearly level terraces in flatwoods. It is less well drained than the associated Cassia soils but better drained than Basinger soils (Baldwin et al. 1980).

Spoil banks are piles of soil material dug from large ditches and canals or dredged from ship channels in the Indian River. On the mainland, spoil banks occur as long, narrow areas adjacent to the ditches and canals from which they were dug. In the Indian River, they occur as scattered islands near the ship channel from which they were dredged. Properties of spoil banks vary depending on the material from which they were taken (Huckle et al. 1974). The soil coverage from the St. Johns River Water Management District uses Arents and Udorthents for this material.

Swamp includes nearly level, poorly drained and very poorly drained areas of soils with dense cover of wetland hardwoods, vines, and shrubs in poorly defined drainageways, depressions, and large bay heads. They are flooded with freshwater most of the time. The soil pattern is intricate, varied, and impractical to map separately and includes Anclote, Basinger, Pompano, Terra Ceia, and Tomoka soils (Huckle et al. 1974).

Submerged marsh is the mapping unit used for areas on the lagoonward side of marshes impounded for mosquito control (Huckle et al. 1974). These are now flooded for much of the year; they may be primarily open water or may still support some marsh vegetation. The soil coverage from the St. Johns River Water Management District uses Turnbull and Riomar soils–tidal for these soils.

Tavares fine sand is a nearly level and gently sloping, well-drained, sandy soil on narrow to broad, moderately low ridges. The water table is between 40-60" (102-152 cm) for > 6 months per year and > 60 in (152 cm) in the dry season. This series is better drained than Immokalee or Myakka but less well drained than Astatula, Paola, or St. Lucie (Huckle et al. 1974). Only minor areas of this series occur on KSC (Table A-1).

Tequesta muck is a nearly level, very poorly drained soil of low flats and freshwater marshes and swamps where conditions favor the accumulation of plant remains. The soil consists of about 12 in (30.5 cm) of sapric muck over sand (Baldwin et al. 1980).

Tidal marsh includes nearly level areas of soils covered with salt or brackish waters at high tide. Soils are highly variable and include shallow mucky sands over marl or limestone, irregularly stratified mixed sand and shell fragments, silty or clayey layers over sand and shells, and deep organic material (Huckle et al. 1974). Tidal marsh is mapped in Brevard County for marsh areas adjacent to the lagoon systems (Indian River, Banana River, Mosquito Lagoon) that are not impounded.

Tidal swamp includes nearly level areas at about mean sea level covered with dense tangled growth of mangrove trees and roots. Soil material ranges from mixed sand and shells to organic material (Huckle et al. 1974). This type is mapped in Brevard County for mangrove islands in Mosquito Lagoon and the Banana River and for other unimpounded areas of mangroves adjacent to the lagoon systems. The soil coverage from the St. Johns River Water Management District labels these soils Bessie muck.

Turnbull muck is a very poorly drained soil formed in clayey and sandy estuarine deposits near sea level and periodically flooded by tidal overwash (Baldwin et al. 1980). This series is mapped in marshes bordering the Indian River and Mosquito Lagoon in the Volusia County section of KSC.

Turnbull variant sand consists of mixed sandy and shelly material dredged from the Intracoastal Waterway and placed in narrow strips along it over underlying material of organic deposits and layers of clayey and sandy estuarine deposits (Baldwin et al. 1980). Minor areas (Table A-1) of this soil are mapped in the Volusia County section of KSC. It appears to be similar or identical to the Spoil bank type in Brevard County (Huckle et al. 1974).

Tuscawilla fine sand is a nearly level, poorly drained soil in broad hammocks near the coast. The water table is < 10 in for 2-6 months per year (Baldwin et al. 1980). Areas of this soil are mapped in the northern part of Merritt Island in Volusia County.

Urban land consists of areas that are 60 to > 75 percent covered with streets, buildings, parking lots, and similar structures (Huckle et al. 1974).

Valkaria fine sand is a nearly level, poorly drained soil of sloughs, depressions, and low areas bordering swamps (Baldwin et al. 1980).

Wabasso loamy sand is a nearly level, poorly drained, sandy soil on broad areas in the flatwoods and on low ridges of floodplains. The water table is < 10 in (25 cm) for 1-2 months per year and < 30 in (76 cm) most of the time; during the dry season it may be > 30 in (76 cm) for short periods. These soils may be flooded for 2-7 days once in 1-5 years (Huckle et al. 1974). On KSC, this series occurs on broad flats on the western side of Merritt Island.

Winder sand is a nearly level, poorly drained, sandy soil in low areas and on low ridges. The water table is < 30 in (76 cm) most of the time and < 10 in (25 cm) for 2-6 months per year. During short, dry periods it may be > 30 in (76 cm); these soils may be flooded occasionally for 2-7 days (Huckle et al. 1974). Only small areas of this soil are mapped separately on KSC (Table A-1); others are included in the Felda and Winder class.

Table A-1. Areas of Soil Series on Kennedy Space Center. Areas Derived from a Soil Coverage Provided by St. Johns River Water Management District from the Original Soil Maps of Brevard and Volusia Counties.

Soil Series or Land Type	Area (acres)	Area (ha)
Anclote sand	2282.6	923.8
Arents (includes some spoil)	286.0	115.7
Astatula fine sand (Candler)	584.7	236.6
Astatula (Candler)-Urban land complex	1.3	0.5
Basinger sand	1094.1	442.8
Beaches	577.3	233.6
Bradenton fine sand	714.0	288.9
Bulow sand	58.1	23.5
Canavera sand	390.3	158.0
Canaveral – Urban land complex	457.3	185.1
Canova peat	18.0	7.3
Chobee fine sandy loam	203.1	82.2
Cocoa sand	925.0	374.4
Copeland complex	4605.4	1863.7
Daytona sand	95.1	38.5
Felda (Riviera) and Winder	4072.7	1648.2
Felda (Riviera) and Winder, ponded	4402.2	1781.5
Floridana	75.6	30.6
Hydraquents	1082.0	437.9
Immokalee sand	14409.1	5831.2
Malabar sand	1.8	0.7
Montverde peat (Everglades mucky peat)	2.5	1.0
Myakka sand	4300.9	1740.5
Myakka, ponded	26.4	10.7
Myakka, variant	69.1	28.0

Table A-1. Areas of Soil Series on Kennedy Space Center. Areas Derived from a Soil Coverage Provided by St. Johns River Water Management District from the Original Soil Maps of Brevard and Volusia Counties (continued).

Myakka-Urban land complex	9.9	4.0
Orsino fine sand	104.1	42.1
Palm Beach sand	1765.7	714.6
Paola fine sand	1262.8	511.0
Parkwood (Hilolo) fine sand	147.3	59.6
Pineda fine sand	484.8	196.2
Pineda sand, dark surface variant (Delray sand – commonly flooded)	170.9	69.2
Pits	6.0	2.3
Placid fine sand, depressional	83.1	33.6
Pomello sand	2048.3	828.9
Pomona-St. Johns complex	5.8	2.3
Pompano	298.1	120.6
Pompano-Placid complex	540.3	218.6
Quartipsamments	345.2	139.7
Riviera fine sand (includes Felda)	572.0	231.5
St. Johns fine sand	3080.8	1246.7
St. Johns, ponded	1424.3	576.4
St. Lucie fine sand	16.7	6.8
Samsula muck	304.2	123.1
Spoil banks (Udorthents)	15.3	6.2
Submerged marsh and Tidal marsh (Turnbull and Riomar soils – tidal)	21911.0	8867.1
Swamp (Anclote sand-frequently flooded)	167.6	67.8
Tavares fine sand	44.6	18.1
Tequesta muck	?	?
Tidal swamp (Bessie muck)	225.5	91.3
Turnbull muck	570.4	230.8
Turnbull variant sand	86.5	35.0
Tuscawilla fine sand	413.1	167.2
Urban land	1771.1	716.7
Wabasso fine sand	3704.2	1499.0
Winder sand loam	6.7	2.7

Note: Names in parentheses differ in the coverage from those in the original maps.

Table A-2. Soil Classes with the Series and Land Types in Each[1].

Soil Class and Series	Soil Subgroup
Coastal	
Canaveral	Aquic Udipsamment
Palm Beach	Typic Udipsamment
Welaka	Spodic Quartzipsamment
Acid Scrub	
Astatula	Typic Quartzipsamment
Cassia	Typic Haplohumod
Daytona	Entic Haplohumod
Orsino	Spodic Quartzipsamment
Paola	Spodic Quartzipsamment
Pomello	Arenic Haplohumod
St. Lucie	Typic Quartzipsamment
Satellite	Aquic Quartzipsamment
Tavares	Typic Quartzipsamment
Coquina Scrub	
Bulow	Typic Hapludalf
Cocoa	Psammentic Hapludalf
Flatwoods	
Holopaw	Grossarenic Ochraqualf
Immokalee	Arenic Haplaquod
Myakka	Aeric Haplaquod
Myakka variant	Aeric Haplaquod
Pompano	Typic Psammaquent
Smyrna	Aeric Haplaquod
St. Johns	Typic Haplaquod
Wabasso	Alfic Haplaquod
Winder	Typic Glossaqualf
Hammocks	
Bradenton, shallow variant	Typic Orchaqualf
Copeland	Typic Argiaquoll
Parkwood	Mollic Orchaqualf
Tuscawilla	Typic Orchaqualf

[1] Schmalzer et al. (2001)

Table A-2. Soil Classes with the Series and Land Types in Each[1] (continued).

Soil Class and Series	Soil Subgroup
Freshwater Wetlands	
Anclote	Typic Haplaquoll
Basinger	Spodic Psammaquent
Canova	Typic Glossaqualf
Chobee	Typic Argiaquoll
Felda & Winder	Arenic Orchaqualf/Typic Glossaqualf
Felda & Winder, ponded	Arenic Orchaqualf /Typic Glossaqualf
Floridana	Arenic Argiaquoll
Immokalee, depressional	Arenic Haplaquod
Myakka, ponded	Aeric Haplaquod
Pineda	Arenic Orchaqualf
Riviera	Arenic Glossaqualf
Samsula muck	Terric Medisaprists
St. Johns, ponded	Typic Haplaquod
Swamp	N/A
Tequesta muck	Arenic Glossaqualf
Valkaria	Spodic Psammaquent
Saltwater Wetlands	
Submerged Marsh	N/A
Tidal Marsh	Hydraquents
Tidal Swamp	Hydraquents
Hydraquents	Hydraquents
Citrus Scrub	Acid Scrub and Coquina Scrub types
Citrus Hammock	Hammock types
Disturbed	
Canaveral-urban land	Entisol
Galveston-urban land	Entisol
Urban land	Entisol
Quartzipsamments	Entisol
Arents	Entisol
Spoil Banks	Entisol
Dikes	Entisol
Made land	Entisol
Turnbull variant	Aquic Udipsamment

[1] Schmalzer et al. (2001)

APPENDIX B

FISH FAUNA OF THE KSC AREA [1]

I. Salinity Regime:

- (M) – Mesohaline > 15 ppt
- (0) – Oligohaline 1-14 ppt
- (F) – Fresh < 1 ppt

II. Habitat Types:

- Open Lagoon (OL) – Depths > 0.5 M
- Lagoon Fringe (FL) – Depths < 0.5M around shores and spoil islands
- Marsh (MR) – Marshes, creeks and bays with shallow water, silt substrates, fringe-mangroves or marsh grasses
- Ditches (D) – Man-made ditches and canals
- Impoundments (I) – Mosquito control impoundments
- Ponds (P) – Man-made borrow ponds, flooded swales

III. Relative Abundance:

- R **–** Rare: 5 or fewer specimens
- O **–** Occasional: Collected or observed at irregular intervals
- F **–** Frequent: Observed or collected on numerous occasions or recorded in large percentage of collections from the appropriate habitat
- C **–** Common: Present in virtually every collection from the appropriate habitat
- A **–** Abundant: Common species present in large numbers

[1] Adapted from: Snelson, F.F., Jr. 1983. Ichthyfauna of the Northern Part of the Indian River Lagoon System, Florida. Florida Scientist. 46 : 187-206

See Table B-1 Fishes of KSC Waters.

Table B-1. Fishes of KSC Waters.

Habitat						
	OL	FL	M	D	I	P
Carcharhinidae – Requium Sharks						
1. Bull Shark (M) *Carcharhinus leucas*	F					
2. Blacktip Shark (M) *Carcharhinus limbatus*	0					
3. Sandbar Shark (M) *Carcharhinus plumbeus*	R					
4. Lemon Shark (M) *Negaprion brevirostris*	0					
Sphyrnidae – Hammerhead Sharks						
5. Scalloped Hammerhead (M) *Sphyrna lewini*	0					

Table B-1. Fishes of KSC Waters (continued).

Habitat						
	OL	FL	M	D	I	P
Pristidae – Sawfises						
6. Smalltooth Sawfish (M) *Pristis pectinata*	R					
Dasyatidae – Stingrays						
7. Southern Stingray (M) *Dasyatis Americana*	0					
8. Atlantic Stingray (M) *Dasyatis Sabina*	C					
9. Bluntnose Stingray (M) *Dasyatis sayi*	C					
10. Smooth Butterfly Ray (M) *Gymnura micrura*	0					
Myliobatidae – Eagle Rays						
11. Spotted Eagle Ray (M) *Aetoatus narinari*	0					
12. Cownose Ray (M) *Rhinoptera bonasus*	F					
Lepisosteidae – Gars						
13. Florida Gar (F, O) *Lepisosteus platyrhincus*				F	F	F
Amiidae – Bowfins						
14. Bowfin (F) *Amia calva*					0	
Elopidae – Tarpons						
15. Lady fish (O, M) *Elops saurus*	F	F	F	F	F	
16. Tarpon (M, O) *Megalops atlanticus*	0		0	0	0	
Albulidae – Bonefishes						
17. Bone fish (M) *Albula vuloes*	R					
Anguillidae – Freshwater Eels						
18. American Eel (M, O) *Anguilla rostrata*	0			0		
Ophichthidae – Snake Eels						
19. Speckled Worm Eel (M) *Myrophis unctatus*	F					
20. Shrimp Eel (M) Ophichthus gomesi	R					
Clupeidae – Herrings						
21. Yellowfin Menhaden (M) *Brevoortia smithi*	C					
22. Atlantic Menhaden (M) *Brevoortia smithi*	F					
23. Gizzard Shad (M, O) *Dorosoma cepedianum*	0		0	0		
24. Scaled Sardine (M) *Harangula jaguana*	A					
25. Atlantic Thread Herring (M) *Opisthonema oglinum*	C					
Engraulidae – Anchovies						
26. Cuban Anchovy (M) *Anchoa cubana*	0					
27. Striped Anchovy (M) *Anchoa hepsetus*	F					
28. Bay Anchovy *Anchoa mitchilli*	A	A				
29. Longnose Anchovy *Anchoa nasuta*	R					
Synodontidae – Lizardfishes						
30. Inshore Lizardfish (M) *Synodus foetens*	0					
Cyprinidae – Minnows						
31. Golden Shiner (F) *Notemigonus crysoleucas*				F	F	F
Catostomidae – Suckers						
32. Lake Chubsucker (F) *Erimyzon sucetta*				F	F	F

Table B-1. Fishes of KSC Waters (continued).

Habitat						
	OL	FL	M	D	I	P
Ictaluridae - Bullhead Catfishes						
33. Yellow Bullhead (F) *Ictaluris natalis*				0	0	0
Ariidae – Sea Catfishes						
34. Hardhead Catfishes (M) *Arius felis*	C					
35. Gafftopsail Catfish (M) *Bagre marinus*	F					
Batrachoididae – Toadfishes						
36. Oyster Toadfish (M) *psanus tau*	F	F				
Gobiesocidae – Clingfishes						
37. Skilletfish (M) *Gobiesox strumosus*	F					
Ophidiidae – Cusk Eels						
38. Striped Cusk-Eel (M) *Ophidion marginatum*	R					
Exocoetidae – Flyingfishes						
39. Atlantic Flyingfish (M) *Cypselurus melanurus*	R					
40. Halfbeak (M) *Hyporhamphus unifasciatus*	O					
Belanidae – Needlefishes						
41. Atlantic Needlefish (O, M) *Strongylura marina*	O	O	O	O	O	
42. Redfin Needlefish (O, M) *Strongylura notata*	C	C	C	C	C	
43. Timucu (M) *Strongylura timucu*	R	R				
Cyprinodontidae Killifishes						
44. Sheepshead Minnow (O, M) *Cyprinodon variegates*	O	A	A	A		
45. Goldspotted Killifish (M, O) *Floridichtyhys carpio*	O	A	A			
46. Golden Topminnow (F) *Fundulus chrysotus*				F	F	F
47. Marsh Killifish (O, M) *Fundulus confluentus*			F	F	F	
48. Gulf Killifish (M, O) *Fundulus grandis*		C	C	C	C	
49. Mummichog *Fundulus heteroclitus*	R					
50 Seminole Killifish (F, O) *Fundulus seminolis*				O	O	O
51. Longnose Killifish (M) *Fundulus similes*			O			
52. Flagfish (F) *Jordinella floridae*				F	F	F
53. Bluefin Killifish (F) *Lucania goodie*				C	C	C
54. Rainwater Killifsh (O, M) *Lucania parva*	A	A	A	A	A	
Poeciliidae – Livebearers						
55. Mosquitofish (F, O, M) *Gambusia affnus*		A	A	A	A	A
56. Least Killifish (F) *Heterandria Formosa*				F	F	F
57. Sailfin Molly (M, O, F) *Poecilia latipinna*	R	A	A	A	A	R
Atherinidae – Silversides						
58. Rough Silverside (M) *Membras martinica*		O				
59. Inland Silverside (M) Men*idia beryllina*					O	O
60. Tidewater Silverside (M, O) *Menidia peninsulae*			A	A	A	A
Syngnathidae – Pipefishes						
61. Lined Seahorse (M) *Hippocampus erectus*	O	O				
62. Dwarf Seahorse (M) Hippocampus zosterae	F	F				

Table B-1. Fishes of KSC Waters (continued).

Habitat						
	OL	FL	M	D	I	P
63. China Pipefish (M) *Syngnathus louisianae*	O					
64. Gulf Pipefish (M, O) *Syngnathus scovelli*	C	C	C			
Centropomidae – Snooks						
65. Snook (M, O) *Centropomus undecimalis*	F	F	F	O		
Serranidae – Sea Basses						
66. Rock Sea Bass (M) *Cetropristis philadelphica*	R					
67. Gag (M) *Mycteroperca microlepis*	O					
Centrarchidae – Sunfishes						
68. Warmouth (F) *Lepomis gulosus*				F	F	F
69. Bluegill (F) *Lepomis macrochirus*				C	C	C
70. Dollar Sunfish (F) *Lepomis marginatus*				O	O	O
71. Redear Sunfish (F) *Lepomis microlophus*				F	F	F
72. Spotted Sunfish (F) *Lepomis punctatus*				R		
73. Largemouth Bass (F, O) *Micropterus salmoies*				F	F	F
74. Black Crappie (F) *Pomoxis nigromaculatus*					R	
Pomatomidae – Bluefishes						
75. Bluefish (M) *Pomatomus saltatrix*	O					
Echeneidae – Remoras						
76. Sharksucker (M) *Echeneis naucrates*				R		
77. Whitefin Sharksucker (M) *Echeneis neucratoides*	R					
78. Blue Runner (M) *Caranx crysos*	R					
79. Crevalle Jack (M) *Caranx hippos*	C					
80. Horse-eye Jack (M) *Caranx latus*	O					
81. Atlantic Bumper (M) *Chloroscombrus chrysurus*	O					
82. Leatherjacket (M) *Oligoplites saurus*	F	F				
83. Atlantic Moonfish (M) *Selene setaphinnis*	R					
84. Lookdown (M) *Selene vomer*	O					
85. Florida Pompano (M) *Trachinotus carolinus*	O					
86. Permit (M) *Trachinotus falcatus*	O					
Lutjanidae – Snapper						
87. Gray Snapper (M) *Lutjanus griseus*	F	F				
Lobotidae – *Tripletails*						
88. Tripletail (M) *Lobotes surinamensis*	R					
Gerreidae – Mojarras						
89. Irish Pompano (M) *Diapterus auratus*	F					
90. Striped Mojarra (M) *Diapterus plumieri*	R					
91. Spotfin Mojarra (M) *Eucinostomus argenteus*	C	C				
92. Silver Jenny (M) *Eucinostomus gula*	C	C				
93. Pigfish (M) *Orthopristis chrystoptera*	F					
Sparidae – Porgies						
94. Sheepshead (M) *Archosargus probatocephalus*	C					
95. Pinfish (M) *Lagodon rhomboids*	C	C				

Table B-1. Fishes of KSC Waters (continued).

Habitat						
	OL	FL	M	D	I	P
Sciaenidae – Drums						
96. Silver Perch (M) Bairdiella chrysoura	A					
97. Spotted Seatrout (M) Cynoscion nebulosus	C					
98. Weakfish (M) Cyoscion regalis	F					
99. Spot (M) Leiostomus xanthurus	C					
100. Southern Kingfish (M) Menticirrhus americanus	F					
101. Atlantic Croaker (M) Micropogonias undulates	F					
102. Black Drum (M) Pogonias cromis	F	F	F			
103. Red Drum (M) Sciaenops ocellata	F	F	F			
Ephippidae – Spadefish						
104. Atlantic Spadefish (M) Chaetodipterus faber	F					
Scaridae – Parrotfishes						
105. Emerald Parrotfish (M) **Nicholsina usta**	R					
Mugilidae – Mullets						
106. Striped Mullet (M, O) Mugil cephalus	C	C	C	C	C	
107. White Mullet (M) Mugil curema	C	C	C			
Sphyraenidae – Barracudas						
108. Great Barracuda – (M) Sphyraena borealis	R					
109. Northern Sennet (M) Sphyraena borealis	R					
Uranoscopidae – Stargazers						
110. Southern Stargazer (M) Astroscopus y-graecum	R					
Blenniidae – Combooth Blennnies						
111. Florida Blenny (M) Chasmodes saburrae	C	C				
112. Crested Blenny (M) Hypleurochilus geminatus	R					
Eleotridae – Sleepers						
113. Fat Sleep (O, F) *Dormiator maculates*				O	O	
Gobiidae – Gobies						
114. Frillfin Gobyh (M) *Bathygobius soporator*		R				
115. Lyre Goby (M) *Evorthodus lyricus*		R	R			
116. Violet Goby (M) *Gobioides broussonneti*		R				
117. Darter Gobie (M) *Gobinellus boleosoma*		R				
118. Highfin Goby (M) *Gobionellus oceanicus*		O				
119. Emerald Goby (M) *Gobionellus smaragdus*		R				
120. Naked Goby (O) *Gobioides bosci*			F	F	F	
121. Code Goby (M, O) *Gobiosoma robustum*	A	A	A			
122. Clown Goby (M, O) *Microgobius gulosus*	C	C	C	C	C	
123. Green Goby (M) *Microgobius thalassinus*	O					
Trichiuridae – Cutlassfishes						
124. Atlantic Cutlassfish (M) *Trichirus lepturus*	O					
Scombridae – Mackerels						
125. Spanish Mackerel (M) *Scomberomorus maculates*	O					
Scorpaenidae – Scorpionfishes						

Table B-1. Fishes of KSC Waters (continued).

Habitat						
	OL	FL	M	D	I	P
126. Barbfish (M) Scorpaena brasiliensis	R					
Triglidae – Searobins						
127. Leopard Searobin (M) Prionotus scitulus	O					
128. Bighead Searobin (M) Prionotus tribulus	F					
Bothidae – Lefteye Flounders						
129. Bay Whiff (M) Citharichthys spilopterus	O					
130. Fringed Flounder (M) Etropus crossotus	R					
131. Gulf Flounder (M) Paralichthys albigutta	F					
132. Southern Flounder (M) Paralichthys lethostigma	O					
Soleide – Soles						
133. Lined Sole (M, O) Achirus lineatus	C	C	C	C		
134. Hogchoker (O) Trinectes maculates		F	F	F	F	
Cynoglossidae – Tonguefishes						
135. Blackcheek Tonguefish (M) Symphurus plagiusa	O					
Balisstidae – Leatherjackets						
136. Orange Filefish (M) Aluterus schoepfi	R					
137. Planehead Filefish (M) Monacanthus hispidus	C					
Tetraodontidae – Puffers						
138. Southern Puffer (M) Sphoeroides nephelus	C	C				
139. Bandtail Puffer (M) Sphoeroides spengleri	R					
140. Checkered Puffer (M) Sphoeroides testudineus	R					
Diodontidae – Porcupinefishes						
141. Striped Burrfish (M) Chilomycterus schoepfi	C	C				

APPENDIX C

PROTECTED SPECIES DESCRIPTIONS

The Florida gopher frog (*Rana capito aesopus*) is a medium-sized, chunky frog with short legs, a large head and mouth, and prominent eyes. These frogs are typically creamy white to brownish with irregular dark markings. This species is found in dry upland habitats, where it is highly dependent on the burrows of another protected species, the gopher tortoise, for refuge. During the breeding season these frogs will migrate long distances to seasonally flooded wetlands to breed. The call of breeding males, heard mostly in the winter months in Florida, is a distinctive sound resembling a deep snore. This frog's diet consists primarily of insects, but it is also known to prey upon toads. The xeric habitat required by the Florida gopher frog and the gopher tortoise has been declining due to development. The Florida gopher frog is protected in the state of Florida as a species of special concern.

The American alligator (*Alligator mississippiensis*) is a large crocodilian with a broadly rounded snout. Adult males commonly reach lengths of 3 m (10 ft) or more, while adult females rarely exceed 3 m (10 ft). Individuals over 1.2 m (4 ft) long are mostly black, while younger alligators are black with yellow cross bands on the back, tail, and sides. The American alligator is known to occupy a wide variety of brackish and freshwater wetland habitats. It is able to tolerate human-altered habitats, often occurring in lakes and canals in urban settings. Alligators feed primarily on fish, birds, and reptiles. Females construct large mound nests near to water in which they lay 20 to 50 eggs. Females will then guard their nests throughout the 9-week incubation period. Upon hatching, the young are assisted out of the nest by their mother and will remain with her for at least one year. Until the 1960's alligators were hunted for their hides, reducing populations drastically. In 1967 the American alligator was listed as a protected species by the Federal government. Populations have since been increasing and, in some cases, restored. Current threats include destruction and pollution of wetlands, and confrontations with man. The American alligator is currently protected as a threatened species by the Federal government, due to its similar appearance to the endangered crocodile.

The loggerhead sea turtle (*Caretta caretta*) is a medium to large turtle reaching adult carapace lengths of 70-125 cm (2.3-4.1 ft) and adult weights of 70-180 kg (155-400 lbs). Its limbs are modified as flippers for its mainly aquatic habits. It is distinguished from other Florida sea turtles by its large head, powerful jaws, and reddish-brown carapace. Loggerheads are found in temperate and subtropical waters worldwide, with major nesting beaches in eastern Australia, southeastern Africa, Oman, and the southeastern United States. This species can be found hundreds of miles out to sea, as well as at inshore areas such as bays, lagoons, estuaries, and mouths of large rivers. The diet of loggerheads consists primarily of mollusks, crustaceans, and horseshoe crabs (Dodd, 1992). Nesting in Florida occurs from late April to September, when females briefly leave the water to deposit an average of 110-120 eggs per nest. Most females will nest 2-6 times per season, but only nest every 2-4 years (Dodd, 1992). Hatching occurs about 50-75 days later, when the young typically emerge at night. The major nest predators include raccoons and ghost crabs. Beach lighting can disorient emerging hatchlings, causing the young to head away from the water. Other threats include nesting beach erosion, oceanfront development, and drowning of turtles in shrimp nets. The loggerhead sea turtle is protected as a threatened species by the Federal government.

The Atlantic green turtle (*Chelonia mydas*) is a medium to large turtle, with adult females reaching carapace lengths of 88-117 cm (35-46 in) and weights of 104-177 kg (220-389 lbs). Its limbs are modified as flippers for its mainly aquatic habits. The top of the shell is generally olive with numerous black spots in adults, and solid black in hatchlings. The green turtle is found throughout the world, but predominantly in tropical seas. Nearly all of the species' nesting in the United States occurs on the beaches of eastern Florida, where nesting females emerge briefly to lay their eggs from May to September. Females typically return to the same stretch of beach every two years, where they will deposit up to six clutches averaging 136 eggs each in one season. Hatchlings emerge from nests, immediately swim offshore, and become associated with floating vegetation until reaching one to three years of age when they will return to Florida coastal waters (Ehrhart, 1992). Historically the green turtle has been exploited commercially as food more than any other sea turtle. Current threats include mortality due to drowning in shrimp nets and the development of nesting beaches. The Atlantic green turtle is protected as an endangered species by the Federal government.

The leatherback turtle (*Dermochelys coriacea*) is the largest of all living turtles, with adults reaching carapace lengths of 1.2-2.4 m (4-8 ft) and weights of 295-590 kg (650-1300 lbs). The species can be distinguished from all other marine turtles by its smooth, scaleless dorsal surface, which is black with variable white spotting and has seven narrow, longitudinal ridges. The leatherback turtle is widely distributed throughout the world. Nesting in the United States, however, is confined almost exclusively to the east coast of Florida, where adults emerge briefly to deposit up to 10 clutches of 80-85 eggs each in one season. They will then typically wait 1-2 years before returning to nest again. Leatherbacks feed primarily on jellyfish either at the surface or in the water column. The leatherback turtle is protected as an endangered species by the Federal government.

The gopher tortoise (*Gopherus polyphemus*) is a large terrestrial turtle averaging 23-28 cm (9-11 in) in carapace length. It has stumpy, elephantine hind limbs and flattened, shovel-like forelimbs adapted for digging. Gopher tortoises typically inhabit areas with dry, sandy soils in which they excavate burrows averaging 4.5 m (14.8 ft) in length and 2 m (6.6 ft) in depth. These burrows provide protection from temperature extremes and predators for gopher tortoises as well as a wide variety of other animals. Over 300 species of invertebrates are known to utilize tortoise burrows for refuge, including several obligate species. Numerous vertebrate species also occupy gopher tortoise burrows, including such protected species as the eastern indigo snake, the Florida pine snake, the Florida gopher frog, and the Florida mouse. Gopher tortoises feed on a variety of foods, and serve as an important seed dispersal agent for native grasses and forbs (Diemer 1992). Gopher tortoises exhibit long life spans, with an estimated life expectancy of 40-60 years. Female tortoises do not reach sexual maturity until 10-20 years of age, and only one clutch of 3-12 eggs is produced annually, typically laid in the mound at the mouth of a burrow. Nests receive high levels of predation from raccoons, armadillos, snakes, and other predators. Although the gopher tortoise is widely distributed throughout its range, its numbers have declined and continue to decline due mostly to habitat loss and fragmentation. The gopher tortoise is protected in the state of Florida as a species of special concern.

The eastern indigo snake (*Drymarchon couperi*) is the longest snake in North America, with a maximum recorded length of 2.63 m (8.6 ft). It is a heavy-bodied snake with smooth, shiny scales. Adults are uniformly iridescent black, with the throat often tinged with red, coral, or white. Indigo snakes occupy large home ranges including a broad range of upland and lowland habitats. The indigo snake is not a constrictor, and its prey is usually swallowed alive (Moler, 1992). It is known to feed on virtually any vertebrate, including fish, frogs, turtles, birds, small mammals, and other snakes, including venomous species. In certain portions of its range, the indigo snake spends a considerable amount of time in the tunnels of gopher tortoises, allowing it to escape temperature extremes. This has led to indirect killings of indigos through gassing of tortoise burrows by rattlesnake collectors. The indigo has also been heavily collected for the pet trade in the past, due partially to its handsome appearance and docile demeanor. The biggest threat to eastern indigo snake, however, is habitat loss and fragmentation, increasingly exposing this species to road mortality. The eastern indigo snake is protected as a threatened species by the Federal government.

The Atlantic salt marsh snake (*Nerodia clarkii taeniata*) is a small (maximum 61 cm) water snake that is distinguished from other closely related water snakes by its striped face and neck, and dark belly with light spots. It is a unique snake in that it is one of the few North American reptiles that lives in brackish water but has not developed salt glands. It occurs in the northernmost part of KSC in the coastal marshes between the Atlantic Ocean and Mosquito Lagoon. The snake was Federally listed for two reasons: 1) the loss and degradation of habitat along the east coast, and 2) the hybridization of Atlantic salt marsh snakes with freshwater species of water snakes. Hybridization is possible because man-made habitat alterations bring species of snakes together where they would not naturally occur, resulting in the loss of a pure Atlantic salt marsh snake gene pool. The Atlantic salt marsh snake is listed as a threatened species at both the Federal and state levels.

The Florida pine snake (*Pituophis melanoleucus mugitus*) is a large, stocky snake reaching a maximum length of 2.3 m (7.5 ft). Its dorsal surface is typically a light sandy color saddled with dark brown to reddish blotches. It has a cone-shaped head and snout and a muscular body, allowing it to push its way through loose soil and into the burrows of rodents and reptiles, particularly the tunnel systems of pocket gophers and gopher tortoises (Franz, 1992). The Florida pine snake is a constrictor, known to feed on ground-dwelling birds and their eggs, mice, and pocket gophers. They have a reputation for being good actors. When alarmed, the snake will swell up and hiss loudly by exhaling. These snakes typically occupy dry, upland habitats, although during drought conditions they may seek out open habitats bordering wetlands. There have been serious declines in the numbers of Florida pine snakes throughout their range in the last 20 years due to collection for the pet trade, road mortality, and habitat loss and fragmentation (Franz, 1992). The Florida pine snake is protected in the state of Florida as a species of special concern.

The eastern brown pelican (*Pelecanus occidentalis carolinensis*), a subspecies of the brown pelican, is a familiar year-round resident of the Florida coast. It is a large bird, measuring 122 cm (48 in) in length with a wingspan of 2 m (6.6 ft). Adults are brownish black on the breast and belly, and white on the head and neck. Pelicans can be distinguished from other birds by their long, pouched bill. They can be seen foraging over the ocean as they plunge-dive for fish. They typically nest in mangroves in large breeding colonies. Between 1957 and 1961, the brown pelican suffered declines throughout its range due to the use of pesticides that have since been banned in the United States. As a result of this ban, populations have since increased in many areas. The eastern brown pelican is currently protected in the state of Florida as a species of special concern.

The snowy egret (*Egretta thula*) is a small egret, standing 60 cm (24 in) tall with a wingspan of 1 m (40 in). It is all white with a thin black bill, black legs, and bright yellow lores and feet. During the breeding season adults have prominent white plumes on the head, neck, and back. The snowy egret is widely distributed in both freshwater and coastal wetlands throughout most of Florida. This species typically nests in large colonies over standing water, often with other species of birds. The most common food sources are aquatic invertebrates, fish, and insects. The number of snowy egrets nesting in Florida was seriously depreciated during the plume-hunting era. Although the species recovered quite rapidly once granted protection in 1910, the numbers have since begun to decline again, possibly due to the alteration and destruction of the species wetland habitats. The snowy egret is protected in the state of Florida as a species of special concern.

The little blue heron (*Egretta caerulea*) is a medium-sized heron, standing 60 cm (24 in) tall with a wingspan of 1 m (40 in). Adults are slate blue with a reddish head and neck, and have a bluish bill with a black tip. The legs are dark. During the breeding season, adults have long plumes on the back and head. The plumage of juveniles is white with slate-gray wingtips. Molting one-year birds are mottled with slate blue and white. The little blue heron is distributed widely throughout Florida, breeding in freshwater, brackish, and saltwater habitats, and often nesting in large colonies with other species of birds. They seem to prefer foraging in freshwater habitats, feeding on fish, amphibians, aquatic invertebrates, and insects. Population estimates in Florida indicate a decrease in numbers over the past few decades, probably associated with the loss and alteration of Florida's wetlands. The little blue heron is protected in the state of Florida as a species of special concern.

The tricolored heron (*Egretta tricolor*) is a medium-sized heron, standing 66 cm (26 in) tall with a wingspan of 1 m (40 in). It is slate-blue on the head, neck, and upper wings and body. The chest is purplish, in sharp contrast to a white belly. During the breeding season, adults have distinctive yellow-brown plumes across the lower back. The tricolored heron is closely associated with wetlands throughout Florida, but is most common in estuarine habitats. Like most wading birds, tricolored herons nest on islands or in woody vegetation over standing water, often in large groups with other species of birds. They feed primarily on small fish, and to a lesser extent on amphibians and aquatic invertebrates. Although the tricolored heron remains a commonly seen bird in Florida, data suggest that total numbers are declining. This is likely due to the loss and alteration of Florida's wetlands, where this species builds its nests. The tricolored heron is protected in the state of Florida as a species of special concern.

The reddish egret (*Egretta rufescens*), Florida's least common egret, is a medium-sized heron standing 76 cm (30 in) tall with a wingspan of 1.2 m (4 ft). It is a dark heron with deep reddish brown on the head and neck, and slate blue on the body. During the breeding season, adults have long plumes on the back, head, and neck. The bill is pink with a black tip and the legs are slate blue. The reddish egret is almost entirely a coastal species, nesting on mangrove islands and feeding in the surrounding shallows. This species has a unique foraging behavior in which it dashes about rapidly with wings open, feeding on fish, aquatic invertebrates, and small vertebrates. It appears that the Florida population of this species has never recovered from the impact of plume-hunting almost a century ago. Despite encouraging signs in certain parts of its range, it remains a rare bird. The reddish egret is protected in the state of Florida as a species of special concern.

The white ibis (*Eudocimus albus*) is a medium-sized wading bird, standing 64 cm (25 in) tall. It is a mostly white bird with black wingtips and a decurved bill. During the breeding season adults have a bright red face, bill, and legs. Immature birds are brown with white underparts. White ibises nest in large colonies in freshwater marshes, shallow lakes, and estuaries throughout the state of Florida. They may be seen in enormous numbers when moving between feeding and roosting areas. They feed primarily on aquatic invertebrates including crabs, crayfish, and snails, as well as on snakes and insects. The Florida population of this species has experienced drastic declines and fluctuations since the early 1900's due to human development and disturbance to wetland habitats. The white ibis is protected in the state of Florida as a species of special concern.

The roseate spoonbill (*Ajaja ajaja*) is a long-legged wading bird, standing 81 cm (32 in) tall. Adults are bright pink with a featherless head. The species' most distinguishing characteristic is its broad, flattened. The spoonbill feeds by sweeping its bill through shallow water, and snapping it shut on fish, crustaceans, and insects detected by feel. Spoonbills often feed in small groups at night wherever concentrations of prey occur in shallow, coastal habitats. Tremendous numbers of spoonbills were killed for their plumage and wings during the late 1800's and early 1900's. Although their numbers have since increased in suitable habitat, much of their natural habitat has been altered and destroyed in more recent times for the development of coastal areas. The roseate spoonbill is protected in the state of Florida as a species of special concern.

The wood stork (*Mycteria americana*) is the only true stork native to North America. It is white except for black wing tips and a short black tail. Its head and long legs are unfeathered, and the heavy black bill is slightly downcurved. It stands at 102 cm (40 in) tall. Storks are birds of freshwater and brackish wetlands, primarily nesting in cypress and mangrove swamps, and feeding in freshwater marshes and seasonally flooded areas. Typical feeding sites are depressions where fish become concentrated during periods of drought. Wood storks feed by moving their open bills through shallow water. When the bill comes into contact with a fish or other prey item, an extremely rapid bill-snap reflex is triggered. The speed with which the wood stork snaps its bill shut is one of the fastest known reflexes in the animal kingdom. Wood storks have been identified as one of the most endangered wading birds in Florida due to almost routine nesting failures brought on by poor feeding conditions in the much manipulated wetlands of southern Florida (Kale, 1978). The wood stork is protected as an endangered species by the Federal government.

The bald eagle (*Haliaeetus leucocephalus*) is a large raptor with a total length of 79-94 cm (31-37 in) and a wingspan of nearly 2 m (6.6 ft). Adults have a white head and tail, a dark brown body and wings, and yellow eyes, bill, and feet. Juveniles are uniformly brown, often with white mottling on the tail, belly, and wings. The bald eagle is distributed throughout much of North America and northern Mexico. Bald eagle habitat is primarily riparian, typically associated with the coast or with the shores of rivers and lakes. They usually nest near bodies of water where they feed primarily on fish, as well as waterfowl and small mammals. Historically, the bald eagle suffered reproductive failures from the use of pesticides that have since been banned in the United States. Other threats include nesting habitat loss and disturbance. The bald eagle is protected as a threatened species by the Federal government.

The Arctic peregrine falcon (*Falco peregrinus tundrius*) is a medium-sized falcon measuring about 38-50 cm (16-20 in) in length with a wingspan of about 1 m (40 in). Adults are slate-gray on the back, with a dark cap on the head and a distinctive sideburn streak extending down through the eye. The breast is white with dark barring, and the feet are bright yellow. The wings are long and pointed. Peregrines feed almost entirely on other birds, which are caught in midair. Peregrines are one of the fastest birds in nature, reaching speeds of 183 km/hr (114 mph). It is a widespread, migratory species that can be seen in Florida in the winter months. Historically, the peregrine falcon suffered a dramatic decline in population numbers due to reproductive failures caused by the use of pesticides that have since been banned in the United States. This species is protected in the state of Florida as an endangered species.

The southeastern American kestrel (*Falco sparverius paulus*), a subspecies of the American kestrel, is a small falcon measuring 25 cm (10 in) in length. Both sexes have a rust-colored back and tail, two black facial stripes, and a yellow bill and feet. The male’s wings are slate gray, while the female’s wings are rust-colored. This subspecies is restricted to an area from South Carolina south to southern Alabama and Florida, and is nonmigratory. It feeds mainly on large insects, as well as small rodents and reptiles. The preferred habitat in Florida is essentially open pine forests and clearings, where these cavity nesters lay their eggs in dead trees. There has been a significant decline in the numbers of southeastern kestrels in Florida. Although the cause of this decline is undetermined, destruction of nesting habitat is a likely cause (Kale, 1978). The southeastern American kestrel is protected in the state of Florida as a threatened species.

The least tern (*Sterna antillarum*) is a very small tern measuring 23 cm (9 in) in length, with a 50 cm (20 in) wingspan. It is a mostly white bird with a black crown and nape, and black wingtips. The bill is yellow with a black tip, and the legs and feet are yellow to orange. The top of the wings and back are light gray. Least terns feed by plunge diving and dipping for small fish and aquatic invertebrates. The natural nesting habitat of this species is open, flat beach with coarse sand or shell. It will also use spoil islands and flat tar and gravel rooftops. The development of Florida’s beaches for human recreation and housing has caused destruction and alteration of least tern nesting habitat. Other threats include accidental destruction of nests by boaters and fishermen who frequent spoil islands during the breeding season. The least tern is protected in the state of Florida as a threatened species.

The black skimmer (*Rynchops niger*) is a long-legged, ternlike bird measuring 46 cm (18 in) in length. It has black upperparts, a white forehead and underparts, red feet, and a bright red, black-tipped bill. The black skimmer is unique among birds in having the lower half of the bill longer than the upper half. Skimmers feed by cutting the water’s surface with the lower mandible and snatching up their fish or shrimp prey with a quick, downward snap. Their preferred habitat is coastal beaches and salt marshes where they usually nest in small colonies, often with other species of shorebirds. Development of Florida's coastline has decreased the quantity and quality of nesting sites for this unique bird. The black skimmer is protected in the state of Florida as a species of special concern.

The Florida mouse (*Podomys floridanus*) is brownish to brownish-gray on the back and upper sides, with bright orange-buff on the shoulders and lower sides and a white venter. It has large eyes, ears, and hind feet. Adults measure 179-197 mm (7-8 in) in total length, with a tail of 70-90 mm (3-3.5 in), and weigh 25-49 grams. The Florida mouse has one of the smallest geographical ranges of any North American mammal, and is the only genus of mammal endemic to the state of Florida (Layne, 1992). The species requires a very specific habitat type of deep, sandy soils that support fire-maintained, upland vegetation. It is thought to be an exclusively burrow-dwelling species, often excavating its burrows and nest chambers off the main burrow of a gopher tortoise. The biggest threat to populations of the Florida mouse is the destruction and fragmentation of its restricted habitat for residential development and agriculture. The Florida mouse is protected in the state of Florida as a species of special concern.

The southeastern beach mouse (*Peromyscus polionotus niveiventris*) is a light, buffy-colored coastal subspecies of the oldfield mouse. It has a strikingly white venter and a bicolored tail. It is the largest of the beach mice, averaging 139 mm (5 in) in total length and 52 mm (2 in) in tail length. Its principal habitat is the sea oat zone of primary coastal dunes, although it may also occupy adjoining scrub habitats. Major threats to existing populations include habitat loss and fragmentation, invasion of exotic animals, and beach erosion (Stout, 1992). The southeastern beach mouse is protected as a threatened species by the Federal government.

The Florida manatee (*Trichechus manatus latirostris*), a subspecies of the West Indian manatee, is a massive, fusiform, thick-skinned, nearly hairless aquatic mammal. Florida manatees are gray to gray-brown with a horizontally flattened tail. They possess paddle-like forelimbs and lack hind limbs. Adults range in length from 2.8-3.5 m (9-11.5 ft), and weigh from 400-900 kg. Newborn calves are 1.0-1.5 m (3.3-5 ft) in length and weigh about 20-30 kg. The maximum weight recorded for a Florida manatee is 1620 kg for a 3.75 m (12 ft) long female. The diet is strictly herbivorous but highly diverse, ranging from algae and sea grass to terrestrial plants (Layne, 1978). Florida manatees inhabit sluggish rivers, shallow estuaries, and saltwater bays. The only year-round population of Florida manatees in the United States occurs in the state of Florida, where they often congregate in the warm waters of Florida's many natural springs during the winter months. Manatee habitat in Florida has been and continues to be greatly altered by residential and commercial development of coastal land (Packard and Wetterqvist, 1986). Additional threats include water pollution, the obstruction of migration routes by dams, dredging of food resources, and direct mortality by the propellers of powerboats. The Florida manatee is protected as an endangered species by the Federal government and the State of Florida.

APPENDIX D

KSC RECYCLING AND AFFIRMATIVE PROCUREMENT

- CY 2001 KSC CPG Items Purchasing and Recycling Items
- CY 2001 KSC Recyclable Items
- Method for Recycling Paper and Cardboard
- List of KSC P2 Goals
- Reduction Plans for P2 Goal #6
- CY 2002 KSC Pollution Incident Report Data (as of March 2002)
- KSC EPCRA TRI Data
- KSC AFV Natural Gas Usage
- FY 2001 Vehicles & Other Equipment Energy Usage
- KSC Comprehensive Procurement Guidelines Notification and Request for Waiver Form
- CPG Categorical Items

CY 2001 KSC CPG Items Purchasing and Recycling Items

CPG Item Name (CY 2001 Data)	Quantity Purchased	Amount ($)	Recycled Quantity Purchased	Recycled Amount ($)	Unit Type
Binders	---	$21,162	---	$8,664	N/A
Building Insulation Products	---	$149	---	$149	N/A
Carpet	---	$356	---	$356	N/A
Carpet Cushion	---	---	---	---	N/A
Engine Coolants	855	$6,123	855	$2,622	Gals
Floor Tiles (rubber or plastic only)	---	---	---	---	N/A
Flowable Fill	315	$23,625	315	$23,625	N/A
Industrial Drums	---	---	---	---	N/A
Landscaping Products	---	$2,033	---	$354	N/A
Mats	---	---	---	---	N/A
Miscellaneous Products	---	---	---	---	N/A
Motor Vehicle Lubricating Oils	---	$122,179	---	$2,012	Gals
Motor Vehicle Tires	266	$39,624	144	$16,001	Units
Office R/ W Containers	---	$1,682	---	$126	N/A
Other Products	---	---	---	---	N/A
Paper and Paper Products	---	$895,177	---	$732,822	N/A
Park Benches	---	$53,365	---	$53,365	N/A
Plastic Clipboards	---	$2,033	---	$354	Each
Plastic Desktop Accessories	---	$10,591	---	$2,468	N/A
Plastic File Folders	---	$1,752	---	$1,752	Each
Plastic Lumber, Landscaping Timbers	---	---	---	---	N/A
Plastic Trash Bags	---	$119,262	---	$84,921	N/A
Playground Equipment	---	---	---	---	N/A
Railroad Grade Crossing Surfaces	---	---	---	---	N/A
Signs, Sign Supports, and Posts	---	$544	---	$544	N/A
Sorbents (Adsorbents and Absorbents)	---	$8,626	---	$410	N/A
Strapping	---	---	---	---	N/A
Structural Fiberboard, Laminated Paperboard	---	---	---	---	N/A
Toner Cartridges	---	$613,249	---	$537,842	Each
Traffic Cones and Traffic Barricades	---	$544	---	$544	Each

CY 2001 KSC Recyclable Items

Recycled Item Name (CY 2001 Data)	Quantity Recycled	Unit Type	Revenue Amount ($)
Aluminum	45,848	Lbs	$13,087
Antifreeze	1,525	Gals	---
Batteries, All Types	16	Lbs	$1
Cardboard	77,400	Lbs	---
Copper	255,940	Lbs	$52,401
Mixed Paper	90,500	Lbs	$982
Scrap Metal	3,443,220	Lbs	$37,748
Tires	954	Units	---
White Paper	636,440	Lbs	$9,451

Methods for Recycling Paper and Cardboard

Who is responsible for recycling paper and cardboard? ***All KSC employees are***. NASA/KSC in conjunction with a designated recycling company has provided desktop trays for the purpose of recycling white ledger paper. This includes white bond, notebook paper, adding machine paper, white computer paper, white copier paper that is not coated (slick), the KSC Bulletin, Spaceport News, and other office newsletters that are not coated. White paper that is printed with colored ink is fine, but colored paper is not. If an employee needs a new desktop box, please contact the *NASA KSC Environmental Program Branch.* Please remember to empty the desktop trays into the blue recycling barrels that are located in your building hallway or janitor's closet.

What does an employee do with all those cardboard boxes? Please remove any packing materials before recycling. The employee must break down all boxes and transport them to the nearest bulk cardboard recycling container that is outside your building. The janitorial staff is only responsible for picking up small boxes the size of copier paper boxes ***after*** the employee has properly broken them down. Please do not clutter the halls with excess boxes.

What does an employee do with shredded paper? Shredded paper can also be recycled. Start by placing a liner in the shredder bin; when the container is full, take the bag with the white shredded paper to a blue recycling barrel located in a hallway or janitor's closet near the employee's office. Empty the shredded white paper in the recycling barrel, ensuring that no shredded colored paper or shredded slick paper is mixed with the shredded white paper.

What does an employee do with newspapers? Take the newspaper home for local curbside recycling.

List of KSC P2 Goals

Goal 1. Develop and implement Environmental Management Systems. KSC must implement an Environmental Management Systems (EMS) by December 31, 2005. When NASA Headquarters has developed the EMS guidance, KSC Environmental Program Branch (EPB) will implement the EMS.

The NASA HQ Environmental Management Division (EMD) conducted a facility level Environmental Management Review (EMR) at KSC on April 30 – May 11, 2001. KSC will integrate the appropriate findings and results of the facility level EMR into this pollution prevention plan.

The Chief of the KSC Environmental Program Branch (EPB) and EMS group should lead the development and the implementation of EMS at KSC.

Goal 2. Establish and implement Environmental Compliance Audit Programs. KSC must conduct Center environmental compliance audits every three years. Each compliance finding should accompany by a solution to remedy the finding and the compliance audits results should address systematically through formal documentation and review procedures.

The Chief of the KSC EPB, the lead of the Environmental Permitting and Compliance group and the lead of the Environmental Management Systems group should determine the compliance audit protocol.

The Chief of the KSC EPB should present the results of compliance audits to senior management and identify actions required of senior management to address non-compliance. Corrective actions will be provided to the responsible parties for resolution.

Goal 3. Revise and update Pollution Prevention Implementation Plan Annually. KSC will revise and update the KSC Pollution Prevention Implementation Plan annually. The plan shall integrate any findings and results from any EMR's or any compliance audits. The plan also shall consider any new rules, regulations or Executive Orders.

Goal 4. Report Center activities under EPCRA Annually. KSC must report releases and transfers of toxic chemicals using the Emergency Planning and Community Right-to-Know Act (EPCRA) Section 313 Toxic Release Inventory (TRI) Form R on every July 1st of each year to the US EPA and the State of Florida State Emergency Response Commission (SERC).

KSC must comply with Sections 301 through 312 of EPCRA. KSC must have and make the material safety data sheets (MSDSs) available to all KSC employees and to local emergency planning committees (LEPC).

KSC must prepare and report the estimate amount of toxic chemicals stored at KSC through the EPCRA Tier II reporting. KSC must report the EPCRA Tier II data to the EPA, the SERC, the LEPC and the KSC Fire Department on every March 1st of each year.

KSC must prepare and report Pollution Prevention activities to the NASA HQ EMD on every October of each year. The report shall include any waste minimization activities in accordance with section 6607 of the Pollution Prevention Act.

The KSC EMS group is responsible for submitting the EPCRA Tier II report, the EPCRA TRI report and the Pollution Prevention report to the US EPA, the SERC, the LEPC, the KSC Fire Department and the NASA HQ EMD.

Goal 5. Reduce KSC Toxic Release Inventory (TRI) releases and off-site transfers of toxic chemicals for treatment and disposal by 10 percent annually, or by 40 percent overall by December 31, 2006. KSC must establish the baseline of TRI releases and off-site transfers of toxic chemicals for treatment and disposal by the end of calendar year 2001.

KSC must reduce the TRI releases and off-site transfers of toxic chemicals for treatment and disposal by 10 percent annually or by 40 percent overall by December 31, 2006.

The KSC EMS group will coordinate source reduction and waste minimization efforts with all KSC contractors to reduce the TRI releases and off-site transfers of toxic chemicals for treatment and disposal.

Goal 6. Reduce the uses or wastes of selected chemicals by 50 percent by December 31, 2006. KSC has selected the following 5 chemicals for 50 percent usage reduction or 50 percent waste reduction by December 31, 2006. The KSC EMS group will coordinate effort with all KSC contractors to reduce the use or waste of the 5 selected chemicals.

Name	CAS	Reduction Type	Baseline
Freon 113	76-13-1	Usage	43,409.5 lbs
Perchloroethylene (Tetrachloroetylene)	127-18-4	Waste	SW – 18,000 lbs Air – 4.5 tons
Methylene Chloride	75-09-2	Usage	1,167 lbs
Ethylene Glycol	107-21-1	Usage	232 lbs
Chromium Compound	N/A	Waste	64,103 lbs

Goal 7. Develop a plan to phase out the procurement of Class I Ozone Depleting Substances by December 31, 2010. The KSC EMS Group, with support from the KSC Environmental Permitting and Compliance group, will coordinate effort with all KSC contractors to develop a plan to phase out the procurement of Class I Ozone Depleting Substances (ODS) by December 31, 2010.

Class I ODS Chemical Name	CAS Number	Current Applications	Procurement	Purchased Amount
CFC-11 (CCl3F) Trichlorofluoromethane	75-69-4	Refrigerant	---	---
CFC-12 (CCl2F2) Dichlorodifluoromethane	75-71-8	Refrigerant Leak Detection Calibration	Yes	180 lbs/yr
CFC-113 (C2F3Cl3) 1,1,2-Trichlorotrifluoroethane	76-13-1	Precision Cleaning Leak Detection Calibration Cryogenics Research	---	---
CFC-114 (C2F4Cl2) Dichlorotetrafluoroethane	76-14-2	Refrigerant Leak Detection Calibration Orbiter Processing	---	---
CFC-115 (C2F5Cl) Monochloropentafluoroethane	76-15-3	Refrigerant	---	---
Halon 1211 (CF2ClBr) Bromochlorodifluoromethane	353-59-3	Fire Protection	---	---
Halon 1301 (CF3Br) Bromotrifluoromethane	75-63-8	Fire Protection	Yes	66 lbs/12 yrs
CFC-13 (CF3Cl) Chlorotrifluoromethane	75-72-9	Leak Detection Calibration	Yes	1 lb/yr
Methyl Chloroform (C2H3Cl3) 1,1,1-trichloroethane	71-55-6	Orbiter Processing	---	---

Goal 8. Implement environmentally sound landscape practices. According to KSC Center Services Division, KSC is currently using an environmentally sound landscape practice by: a) Planting plants that are drought resistance or required minimum watering, b) Using mulches to minimize water evaporation, c) Efficient irrigation, and d) Appropriate maintenance.

Goal 9. Comply with EO 13148 requirements and note EO 13148 recommendations. KSC shall incorporate the goals of EO 13148 into proper KSC Handbooks (KHB) and KSC Management Instructions (KMI) as required.

Reduction Plans For P2 Goal # 6

Usage Reduction Plan for Freon 113 (CAS 76-13-1)

Company	Reduction Type	01 Amt (lbs)	Application	Usage Reduction Plan
JBOSC	Usage	716.0	Used as a cleaning solvent by Wyle Standards and Calibration Laboratory	• Implement reduced cleaning effort (Option 3 of KSC-5713 Report) • Implement CFC-113 vapor recovery system (Appendix A of KSC-5713 Report)
PGOC	Usage	---	Utilizes very little Freon 113, most of which is a component of commercially available products	Commercially procured products will be reviewed for potential product substitution
SFOC	Usage	42,366.0	Precision cleaning by Wiltech; LOX system cleaning at launching pads	• Usage reduction will be met by elimination of CFC-113 by conversion to HFE-7100 and Vertrel at Wiltech. • Facility modifications are currently in work to implement the Vertrel cleaning/recycling system. Once validated, the Freon system will be drained and refilled with the HFE-7100. • Some CFC-113 will be kept for a contingency basis or system flush. The specifications have not been changed to allow system cleaning using the alternative solvents; it is approved at the component level only.
DYNACS	Usage	327.5	Cleaning and Cryogenic lab experiment	No future procurement plan for this chemical once the current 327.5 lbs is used up.

Waste Reduction Plan for Perchloroethylene (CAS 127-18-4)

Company	Reduction Type	01 Amt (SW - lbs)	01 Amt (Air - Tons)	Source	Waste Reduction Plan
SFOC	Waste	18,000	4.5	• Perchloroethylene is an Air Pollutant. Each year 4.5 tons of Perchloroethylene is emitted to the air from the Hypalon Paint Cell. This emission gets reported to the State of Florida as part of the Hypalon Cell Air Permit requirements. This data also gets reported to the EPA under SARA Title III. • Solid waste generated from the hydrolase TPS is a hazardous waste.	• The manufacturer, Gaco-Western, has proposed to replace the Perchloroethylene in the currently used Hypalon paint with an H-27 solvent formulation. • The proposed formulation is considerably more environmentally friendly and significantly reduces the health hazards associated with the processing, handling and disposal.

Usage Reduction Plan for Methylene Chloride (75-09-2)

Company	Reduction Type	01 Amt (lbs)	Application	Usage Reduction Plan
JBOSC	Usage	40	Main usage is as an ingredient in some products used for its solvent properties. Also found in a few aerosol spray paint and aerosol grease spray.	Product substitutions at the shops containing methylene chloride will reduce/eliminate the usage of this chemical
SFOC	Usage	1,127	MCC-1 nozzle cleaning	MCC-1 nozzle flush process change by utilizing hot water for flushing, eliminating the need for methylene chloride use. On hold for hard system replacement, the new process should be in place by 2003. Potential waste reduction of 500 lbs/yr.

Usage Reduction Plan for Ethylene Glycol (CAS 107-21-1)

Company	Reduction Type	01 Amt (lbs)	Application	Usage Reduction Plan
JBOSC	Usage	232	Use as a coolant in vehicles and equipment. It is also an ingredient in latex paint.	• Shops using ethylene glycol as a coolant can try substituting propylene glycol on a trial basis and substitute if meeting performance standards. • Latex paint is a better option than oil-based paint for the environment and as a pollution prevention initiative. Inventory control of the latex on hand may cut down on unused latex paint disposal. • Approximately 855 gallons of ethylene glycol are used and recycled on-site
PGOC	Usage	---	Engine coolants	Almost all coolants are currently recycled through JBOSC (SGS), except for critical specification materials. Specifications materials will be reviewed for potential product substitution

Waste Reduction Plan for Chromium Compound

Company	Reduction Type	01 Amt Usage (lbs)	Source	Waste Reduction Plan
JBOSC	Waste	64,103	• Chromium compounds are routinely found in JBOSC paint waste, especially from the Corrosion Control Facility. • The largest JBOSC waste stream in the 2001 baseline year amounting to 45,295 pounds was plastic blast media. This waste stream is now being completely recycled. • The paint products have specifically authorized for use in the KSC Standard-C-001C Corrosion Control Standard, which has also been expanded for use agency-wide under NASA Standard-50-08. It is unlikely that significant changes can be made to the types of products falling under this standard.	• Of the total 64,103 pounds of waste generated, 45,295 pounds was plastic blast media, which is now being recycled. • The remaining 18,808 pounds of waste containing chromium can be reduced through better inventory controls. • Some reductions may also be achieved in hazardous debris waste streams through better segregation.

CY 2002 KSC Pollution Incident Report
(As of March 2002)

Date (CY 2002)	Substance	Quantity	Location	Description	Cause	Action
1/7/2002	Hypergolic Fuel Scrubber Solution	50 gallons	Facility 77611 Fuel Storage #1 @ CCAFS	During a fuel venting operation, the scrubber burped causing approximately 50 gallons of scrubber solution to spill on paved area.	Equipment failure	Contained in facility sump and cleaned up with waste tanker LT-66.
1/13/2002	Industrial Waste Water (High temp Hot Water)	5001 gallons	M7-505 North Parking Lot	Failure of underground pipeline caused discharge of 5001 gallons, 350^o F HTHW (chemically treated with Sodium Bisulfate at 40-6-PPM) released to grade.		None.
1/21/2002	Diesel fuel	5 gallons	K7-1145 (parking lot at the MFF)	As reported By the SGS Duty Office, an electrical generator was discovered leaking diesel fuel on the paved parking lot at facility K7-1145 (north parking area).	Equipment failure	Quick action by the SGS Generator Shop Mechanics to apply 7 bags of absorbent clay to the spill slowed the flow while the Fire Dept constructed a sand berm to protect the storm water drain. The following morning the SGS Generator shop finished the cleanup at the direction of E. L. Coyle.
2/19/2002	Gasoline	13 0z.	Parking Lot at the OPF High Bay 3	A five-gallon container of gasoline overturned in the back of a JBOSC Security pick up truck. The fuel spilled in the pick up bed and ran onto the pavement.		JBOSC Security applied absorbent clay at the time of spill. The JBOSC Post Emergency Spill Cleanup Team followed up and completed the cleanup, and disposed of the waste with like material.
3/5/2002	Hydraulic oil	4 US gallons	At the entrance of KARS Park II, on Kennedy Space Center	An SGS operated lawn maintenance tractor experienced a hydraulic line failure, spilling approximately 4 gallons of hydraulic on the grass and pavement.	Equipment failure	The JBOSC Post Emergency Spill Cleanup Team responded to, and cleaned up the spill. Cleanup was at the direction of Team Lead Alan Watson.
3/25/2002	Diesel fuel	Less than five gallons	USA Heavy Equipment Yard on Contractor's Road	At approximately 0730, the Heavy Equipment/Proof load Shop personnel were sent to the Heavy Equipment Yard to retrieve a 5-Ton Truck. The personnel noticed a unique smell in the area of the truck. Upon looking further the personnel found an area wet underneath the aircraft tug. The personnel immediately contacted Management who immediately contacted 911, the Safety Group, the Environmental Group and upper management. The area was immediately secured and the Tug was relocated to the Shop where the mechanics positioned a drip pan underneath the leak area.	After securing and relocating, the mechanics drained the tank and found that the drain plug was corroded which caused the slow leak.	The area was immediately secured and the Tug was relocated to the Heavy Equipment Shop where the mechanics positioned a drip pan underneath the leak area. The tug will undergo a thorough inspection and repair prior to returning to service.

KSC EPCRA TRI Data

CAS Number	Chemical Name	2001 TRI Activities Data Manufacture Threshold *(25,000 lbs) unless it is PBT Chemical*	Process Threshold *(25,000 lbs) unless it is PBT Chemical*	OtherWise Use Threshold *(10,000 lbs) unless it is PBT Chemical*	Reportable Code
106898	Epichlorohydrin			226,268.00	REPORT (FORM A)
60344	Methyl hydrazine			45,902.00	REPORT
76131	Freon 113			43,212.40	REPORT
127184	Tetrachloroethylene (Perchloroethylene)			15,146.00	REPORT
7439921	Lead			4,616.80	REPORT
7429905	Aluminum			1,863,484.31	N/R - Not Fume or Dust
7440666	Zinc			19,138.80	40 CFR 372.38 (c)(1) Facility Structure Exmeption
7782505	Chlorine			10,200.55	40 CFR 372.38 (c)(3) Personal Use Exemption
7697372	Nitric acid	2668		1,950.00	Below MFG & OWU Thresholds
N511	Nitrates	7,275.00			Below Manufacturing Threshold

CAS Number	Chemical Name	2000 TRI Activities Data Manufacture Threshold *(25,000 lbs) unless it is PBT Chemical*	Process Threshold *(25,000 lbs) unless it is PBT Chemical*	Otherwise Use Threshold *(10,000 lbs) unless it is PBT Chemical*	Report Status
60-34-4	Methyl hydrazine			79,261	REPORT
76-13-1	Freon-113			53,313	REPORT
106-89-8	Epichlorohydrin			188,557	REPORT (Form A)
75-45-6	Chlorodifluoromethane (HCFC-22)			10,111	40 CFR 372.38 (c)(3) Personal Use Exemption for 9,561 lbs & Below Otherwise Use Threshold for 550 lbs
7429-90-5	Aluminum			1,552,882	Not Fume or Dust Form
7440-66-6	Zinc			13,952	40 CFR 372.38 (c)(1) Facility Structure Exemption
7782-50-5	Chlorine			17,100	40 CFR 372.38 (c)(3) Personal Use Exemption
N511	Nitrate Compounds	23,232			Below Manufacturing Threshold

		1999 TRI Activities Data			
CAS Number	**Chemical Name**	**Manufacture Threshold** *(25,000 lbs)*	**Process Threshold** *(25,000 lbs)*	**Otherwise Use Threshold** *(10,000 lbs)*	**Report Status**
60-34-4	Methyl hydrazine			17,828	REPORT
76-13-1	Freon 113			69,295	REPORT
106-89-8	Epichlorohydrin			113,134	REPORT (Form A)
107-21-1	Ethylene Glycol			12,764	40 CFR 372.38 (c)(4) Motor Vehicle Exemption
7429-90-5	Aluminum			933,006	Not in Fume or Dust Form
7440-66-6	Zinc			14,599	40 CFR 372.38 (c)(1) Facility Structure Exemption
7782-50-5	Chlorine			11,400	40 CFR 372.38 (c)(3) Personal Use Exemption
N511	Nitrate Compounds	13,321			Below Manufacturing Threshold

KSC AFV Natural Gas Usage

KSC AFV Energy (Natural Gas - Therms) Usage

KSC	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Totals
FY-97	3,108	2,524	2,629	3,363	2,669	2,556	2,984	2,665	2,546	3,241	2,974	3,450	34,709
FY-98	3,276	2,830	2,369	2,624	2,683	2,544	3,493	2,889	3,354	3,633	2,987	3,321	36,004
FY-99	3,101	3,395	2,701	3,359	4,238	2,914	3,224	3,351	2,425	3,062	3,248	2,815	37,833
FY-00	2,926	2,793	2,727	2,548	2,974	2,860	3,110	2,862	3,458	3,458	3,483	3,492	36,691
FY-01	3,308	3,575	3,170	2,970	3,641	3,465	2,708	2,064	1,911	2,201	2,312	1,748	33,072
Average	3,144	3,023	2,719	2,973	3,241	2,868	3,104	2,766	2,739	3,119	3,001	2,965	35,662
FDOT	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Totals**
FY-00	---	58	26	54	89	87	26	20	21	49	9	68	506
FY-01	9	39	30	21	42	---	---	18	10	---	29	30	229
Average	5	49	28	38	65	44	13	19	15	24	19	49	367
Total Avg	**3,148**	**3,072**	**2,747**	**3,010**	**3,306**	**2,911**	**3,117**	**2,785**	**2,754**	**3,143**	**3,020**	**3,014**	**36,029**

FY 2001 Vehicles & Other Equipment Energy Usage

	GSA (Vehicles)*				KSC (Vehicles & Equipment)				Total		
	#	**Unit**	**MBtu**	**$**	**#**	**Unit**	**MBtu**	**$**	**MBtu**	**%**	**$**
Diesel	75,308	Gal	10,445	126,246	300,230	Gal	41,642	271,662	52,087	0.37	397,908
Natural Gas **	33,280	Therms	3,328	23,708	209	Therms	21	347	3,349	0.02	24,055
Gasoline	526,713	Gal	65,839	776,595	41,363	Gal	5,170	42,106	71,010	0.51	818,701
Jet Fuel	---	N/A	---	---	102,897	Gal	13,377	137,201	13,377	0.10	137,201
								Total	**139,822**	**1.00**	**1,377,865**

KSC COMPREHENSIVE PROCUREMENT GUIDELINES (CPG) NOTIFICATION AND REQUEST FOR WAIVER FORM

This form must accompany all purchases. Request Originator will complete this form by checking the appropriate box(es) and attaching additional sheets as necessary. Please call the Environmental Program Branch Office at 867-8455 for additional assistance.

- ☐ My item(s) is **not required** by the CPG to contain recycled/recovered content. (Items which must contain recycled/recovered material can be found at www.epa.gov/cpg)

- ☐ My item(s) **contains** recovered materials as listed at www.epa.gov/cpg.

  ____
  (List items here. Use extra sheets as necessary)

- ☐ My item(s) is **on the CPG list, but cannot be purchased** with the required recycled/recovered material content

  ____ because:
  (List item here. Use extra sheets as necessary)

  - ☐ Item is not available competitively from two or more sources.
  - ☐ Item meeting EPA guidelines is only available at an unreasonable price (greater than 10 percent higher).
  - ☐ Item meeting EPA guidelines does not meet quality/performance specifications.
  - ☐ Item meeting EPA guidelines is not available within a reasonable time frame.

WRITTEN JUSTIFICATION AND SUPPORTING DOCUMENTATION FOR NOT PROCURING DESIGNATED ITEMS CONTAINING RECOVERED MATERIAL MUST BE ATTACHED.

____
Request Originator Date

____
Contracting Officer Date

____
Environmental Manager Date

Comprehensive Procurement Guidelines (CPG) Categorical Items

Construction Products Category (13)	Material	Percentage of Postconsumer Materials	Percentage of Total Recovered Materials
Building Insulation Product			
– Rock Wool Insulation	Slag	---	75
– Fiberglass Insulation	Glass cullet	---	20-25
– Cellulose Insulation (loose-fill and spray-on)	Postconsumer paper	75	75
– Perlite Composite Board Insulation	Postconsumer paper	23	23
– Plastic Rigid Foam, Polyisocyanurate Polyurethane: Rigid Foam Insulation	Recovered material	---	9
– Foam-in-Place Insulation	Recovered material	---	5
– Glass Fiber Reinforced Insulation	Recovered material	---	6
– Phenolic Rigid Foam Insulation	Recovered material	---	5
Carpet (Polyester Fiber Face)	Polyethylene terephthalate (PET) Resin	25-100	25-100
Carpet Cushion			
– Bonded Polyurethane	Old carpet cushion	15-50	15-50
– Jute	Burlap	40	40
– Synthetic Fibers	Carpet fabrication scrap	---	100
– Rubber	Tire rubber	60-90	60-90
Cement and Concrete containing Coal Fly Ash	(1)	(1)	(1)
Cement and Concrete containing Ground Granulated Blast Furnace Slag	(1)	(1)	(1)
Latex Paint			
– Consolidated	Recovered material	100	100
– Reprocessed			
– White, Off-White, Pastel Colors	Recovered material	20	20
– Grey, Brown, Earthtones, and Other Dark Colors	Recovered material	50-99	50-99
Floor Tiles	Rubber	90-100	---
	Plastic	---	90-100
Flowable Fill	(2)	(2)	(2)
Laminated Paperboard	Postconsumer paper	100	100
Patio Blocks	Rubber or Rubber blends	90-100	---
	Plastic or Plastic blends	---	90-100
Railroad Grade Crossing Surfaces			
– Concrete	Coal fly ash	---	15-20
– Rubber	Tire rubber	---	85-95
– Steel (BOF Process)	Steel (BOF)	16	25-30
– Steel (EAF Process)	Steel (EAF)	67	100
Shower and Restroom Dividers and Partitions	Plastic	20-100	20-100
	Steel (BOF Process)	16	25-30
	Steel (EAF Process)	67	100
Structural Fiberboard	Recovered materials	---	80-100

(1) Due to variations in coal fly ash, GGBF slag, cement, strength requirements, costs, and construction practices, EPA is not recommending recovered materials content levels for cement or concrete containing coal fly ash or GGBF slag. EPA is, however, providing the following information about recovered materials content:

- Replacement rates of coal fly ash for cement in the production of blended cement generally do not exceed 20 to 30 percent, although coal fly ash blended cements may range from 0 to 40 percent coal fly ash by weight, according to American Society for Testing and Materials (ASTM) C 595, for cement Types IP and I(PM). Fifteen percent is a more accepted rate when coal fly ash is used as a partial cement replacement as an admixture in concrete.
- According to ASTM C 595, GGBF slag can replace up to 70 percent of the Portland cement in some concrete mixtures. Most GGBF slag concrete mixtures contain between 25 and 50 percent GGBF slag by weight. EPA recommends that procuring agencies refer, at a minimum, to ASTM C 595 for the GGBF slag content appropriate for the intended use of the cement and concrete.

(2) Flowable fill is commonly used as an economical fill or backfill in road construction. It is usually a mixture of coal fly ash, water, a coarse aggregate (such as sand), and portland cement. Flowable fill can take the place of concrete, compacted soils, or sand commonly used to fill around pipes or void areas. Other applications include filling in bridge abutments, foundation subbases, or abandoned manholes and wells. Flowable fill can help put significant quantities of coal fly ash and spent foundry sand, two types of recovered materials, back to good use.

- EPA recommends that procuring agencies use flowable fill containing coal fly ash and/or ferrous foundry sands for backfill and other fill applications. Specific content levels will depend on the specifics of the job, including the type of coal fly ash (Class C or Class F) or foundry sand used, strength, set time, flowability needed, bleeding, and shrinkage.
- EPA recommends that procuring agencies use ACI229R-94 and the American Society for Testing and Materials (ASTM) standards when purchasing flowable fill or contracting for construction that involves backfilling or other fill applications.

Landscaping Products Category	**Recovered Material Content Recommendations**
Food Waste Compost	Purchase or use compost made from food wastes for application such as landscaping, seeding of grass or other plants, as nutritious mulch under trees and shrubs, and in erosion control and soil reclamation. EPA further recommends implementing a composting system for these materials when agencies have an adequate volume and sufficient space.
Garden Hoses – Rubber and/or Plastic Soaker Hoses – Rubber and/or Plastic	 60 – 65% (postconsumer) 60 – 70% (postconsumer)
Hydraulic Mulch Paper Wood/Paper	 100% (postconsumer) 100% (total)
Lawn and Garden Edging – Rubber and/or Plastic	 30 – 100% (postconsumer) / 30 – 100% (total)
Lumber Landscaping Timbers and Posts – HDPE – Mixed Plastics/Sawdust – HDPE/Fiberglass – Other Mixed Resins	 25 – 100% (postconsumer) / 75 – 100% (total) 50% (postconsumer) / 100% (total) 75% (postconsumer) / 95% (total) 50 – 100% (postconsumer) / 95 – 100% (total)
Yard Trimmings Compost	Purchase or use compost made from yard trimmings, leaves, grass clippings for application such as landscaping, seeding of grass or other plants, as nutritious mulch under trees and shrubs, and in erosion control and soil reclamation. EPA further recommends implementing a composting system for these materials when agencies have an adequate volume and sufficient space.
Nonpaper Office Products Category	
Binders – Plastic-Covered – Paper-Covered – Pressboard	 25 – 50% 75 – 100% (postconsumer) / 90 – 100% (total 20% (postconsumer) / 50% (total)
Office Recycling Containers – Plastic – Steel – Paper – Corrugated – Solid Fiber Boxes – Industrial Paperboard	 20 – 100% (postconsumer) 16% (postconsumer) / 25 – 30% (total) 25 – 50% (postconsumer) / 25 – 50% (total) 40% (postconsumer) 40 – 80% (postconsumer) / 100% (total)
Office Waste Receptacles – Plastic – Steel – Paper – Corrugated – Solid Fiber Boxes – Industrial Paperboard	 20 – 100% (postconsumer) 16% (postconsumer) / 25 – 30% (total) 25 – 50% (postconsumer) / 25 – 50% (total) 40% (postconsumer) 40 – 80% (postconsumer) / 100% (total)
Solid Plastic Binders – HDPE – PE – PET – Misc. Plastics	 90% (postconsumer) / 90% (total) 30 – 50% (postconsumer) / 30 – 50% (total) 100% (postconsumer) / 100% (total) 80% (postconsumer) / 80% (total)
Plastic Clipboards – HDPE – PS – Misc. Plastics	 90% (postconsumer) / 90% (total) 50% (postconsumer) / 50% (total) 15% (postconsumer) / 15 – 80% (total)
Plastic File Folders – HDPE	 90% (postconsumer) / 90% (total)
Plastic Clip Portfolios – HDPE	 90% (postconsumer) / 90% (total)

Nonpaper Office Products Category (continued)	
Plastic Presentation Folders – HDPE	 90% (postconsumer) / 90% (total)
Plastic Desktop Accessories (polystyrene) – Including desk organizers, sorters, trays, memo, note and pencil holders	25 – 80% (postconsumer)
Plastic Envelopes	25% (postconsumer) / 25 – 35% (total)
Plastic Trash Bags	10 – 100% (postconsumer)
Printer Ribbons	Procure printer ribbon reinking or relocating services or procure reinked or reloaded printer ribbons
Toner Cartridges	Return used toner cartridges for remanufacturing and reuse or purchase a remanufactured or recycled-content replacement cartridge
Park & Recreational Product Category	
Park Benches and Picnic Tables – Plastic – Plastic Composites – Aluminum – Concrete – Steel (BOF Process) – Steel (EAF Process)	 90 – 100% (postconsumer) / 100% (total) 50 – 100% (postconsumer) / 100% (total) 25% (postconsumer) 15 – 40% (total) 16% (postconsumer) / 25 – 30% (total) 67% (postconsumer) / 100% (total)
Plastic Fencing	60 – 100% (postconsumer) / 90 – 100% (total)
Playground Equipment – Plastic – Plastic Composites – Steel (BOF Process) – Steel (EAF Process) – Aluminum	 90 – 100% (postconsumer) / 100% (total) 50 – 75% (postconsumer) / 95 – 100% (total) 16% (postconsumer) / 25 – 30% (total) 67% (postconsumer) / 100% (total) 25% (postconsumer) / 25% (total)
Playground Surfaces – Plastic or Rubber	 90 – 100% (postconsumer)
Running Tracks – Plastic or Rubber	 90 – 100% (postconsumer)
Transportation Products Category	
Channelizers – Plastic – Rubber (base only)	 25 – 95% (postconsumer) 100% (postconsumer)
Delineators – Plastic – Rubber (base only) – Steel (BOF Process) – Steel (EAF Process)	 25 – 90% (postconsumer) 100% (postconsumer) 16% (postconsumer) / 25 – 30% (total) 67% (postconsumer) / 100% (total)
Flexible Delineators	25 – 85% (postconsumer)
Parking Stops – Plastic and/or Rubber – Concrete Containing Coal Fly Ash – Concrete Containing Ground Granulated Blast Furnace Slag	 100% Generally, 20 – 30%, but could be up to 40%; 15% when used as a partial cement replacement as an admixture in concrete 25 – 70%
Traffic Barricades – Plastic (HDPE, LDPE, PET) – Steel (BOF Process) – Steel (EAF Process) – Fiberglass	 80 – 100% (postconsumer) / 100% (total) 16% (postconsumer) / 25 – 30% (total) 67% (postconsumer) / 100% (total) 100%
Traffic Cones – Plastic (PVC and LDPE) – Crumb Rubber	 50 – 100% 50 – 100%

Vehicular Products Category	
Engine Coolants	Reclaim engine coolants on site or contract for offsite reclamation services. Also, request reclaimed engine coolant when having vehicles serviced at commercial service centers and buy it when making direct purchases
Re-refined Lubricating Oils	Use 25% or more re-refined oil base stock for engine lubricating oils, hydraulic fluids, and gear oils
Retread Tires	Purchase retread tires or tire retreading services for vehicular (highway) tires to the maximum extent feasible
Miscellaneous Products Category	
Awards and Plaques – Glass – Wood – Paper – Plastic and Plastic/Wood Composites	 75 – 100% (postconsumer) / 100% (total) 100% (total) 40 – 100% (postconsumer) 50 – 100% (postconsumer) / 95 – 100% (total)
Industrial Drums – Steel – Plastic (HDPE) – Fiber (paper)	 16% (postconsumer) / 25 – 30% (total) 30 – 100% (postconsumer) 100% (postconsumer)
Manual-Grade Strapping – Polyester – Polypropylene – Steel (BOF Process) – Steel (EAF Process)	 50 – 85% (postconsumer) 10 – 40% (total) 16% (postconsumer) / 25 – 30% (total) 67% (postconsumer) / 100% (total)
Mats – Rubber – Plastic – Rubber/Plastic Composite	 75 – 100% (postconsumer) / 85 – 100% (total) 10 – 100% (postconsumer) / 100% (total) 100% (postconsumer)
Pallets – Wood – Plastic – Thermoformed – Paperboard	 95 – 100% (postconsumer) 100% (postconsumer) 25 – 50% (postconsumer) 50% (postconsumer)
Signage – Plastic – Aluminum – Plastic Sign Post/Supports – Steel Sign Posts/Supports (BOF Process) – Steel Sign Post/Supports (EAF Process)	 80 – 100% (postconsumer) 25% (postconsumer) 80 – 100% (postconsumer) 16% (postconsumer) / 25 – 30% (total) 67% (postconsumer) / 100% (total)
Sorbents – Paper – Textiles – Plastics – Wood – Other Organics/Multimaterials	 90 – 100% (postconsumer) / 100% (total) 95 – 100% (postconsumer) 25 – 100% (total) 100% (total) 100% (total)

Paper & Paper Products Category	Notes	Recovered Content (%)	Postconsumer Content (%)
Printing and Writing Papers			
– Reprographic	– Business papers such as bond, electrostatics, copy, mimeo, duplicator, and reproduction	30	30
– Offset	– Used for book publishing, commercial printing, direct mail, technical documents, and manuals	30	30
– Tablet	– Office paper such as note pads and notebooks	30	30
– Forms bond	– Bond type papers used for business forms such as continuous, cash register, sales book, unit sets, and computer printout, excluding carbonless	30	30
– Envelope	– Wove	30	30
	– Kraft, white and colored (including manila)	10 – 20	10 – 20
	– Kraft, unbleached	10	10
	– Excludes custom envelopes	---	---
– Cotton fiber	– High-quality papers used for stationery, invitations, currency, ledgers, maps, and other specialty items	30	30
– Text and cover	– Premium papers used for cover stock, books, and stationery and matching envelopes	30	30
– Supercalendered	– Groundwood paper used for advertising and mail order inserts, catalogs, and some magazines	10	10
– Machine finished groundwood	– Groundwood paper used in magazine and catalogs	10	10
– Papeteries	– Used for invitations and greeting cards	30	30
– Check safety	– Used in the manufacturers of commercial and Government checks	10	10
– Coated	– Used for annual reports, posters, brochures and magazines. Have gloss, dull, or matte finishes	10	10
– Carbonless	– Used for multiple-impact copy forms	30	30
– File folders	– Manila or colored	30	30
– Dyed filing products	– Used for multicolored hanging folders or wallet files	20 – 50	20
– Index and card stock	– Used for index cards and postcards	50	20
– Pressboard	– High-strength paperboard used in binders and report covers	50	20
– Tags and tickets	– Used for toll and lottery tickets, licenses, and identification and tabulating cards	20 – 50	20
Newsprint	– Groundwood paper used in newspapers	20 – 100	20 – 85
Commercial Sanitary Tissue Products			
– Bathroom tissue	– Used in rolls or sheets	20 – 100	20 –60
– Paper towels	– Used in rolls or sheets	40 –100	40 – 60
– Paper napkins	– Used in food service applications	30 – 100	30 – 60
– Facial tissue	– Used for personal care	10 – 100	10 – 15
– General-purpose industrial wipers	– Used in cleaning and wiping applications	40 – 100	40
Paperboard and Packaging Products			
– Corrugated containers			
– (<300 psi)	– Used for packaging and shipping a variety of goods	25 – 50	25 – 50
– (300 psi)		25 – 30	25 – 30
– Solid fiber boxes	– Used for specialized packaging needs such as dynamite packing and army ration boxes	40	40
– Folder cartons	– Used to package a wide variety of foods, household products, cosmetics, pharmaceuticals, detergent, and hardware	100	40 – 80
– Industrial paperboard	– Used to create tubes, cores, cans, and drums	100	45 – 100
– Miscellaneous	– Includes “chipboard” pad backings, book covers, covered binders, mailing tubes, game boards, and puzzles	90 – 100	75 – 100
– Padded mailers	– Made from kraft paper that is usually brown but can be bleached white	5 – 15	5 – 15
– Carrierboard	– A type of folding carton designed for multipack beverage cartons	10 – 100	10 – 15
– Brown papers	– Used for bags and wrapping paper	5 – 40	5 – 20
Miscellaneous Paper Products			
– Tray liners	– Used to line food service trays. Often contain printed information	100	50 – 75